EPA-600/1-78-054
August 1978

CHROMOSOMAL ABERRATIONS IN PERIPHERAL LYMPHOCYTES OF STUDENTS EXPOSED TO AIR POLLUTANTS

by

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Contract No. 68-02-1730

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DISCLAIMER

FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

This report documents the results of a pilot study, supported by EPA, to evaluate the mutagenicity of daily exposure to ozone concentrations in ambient air. Previous clinical studies conducted under controlled conditions had suggested a chromosome breaking potential of photochemical pollutants. Those laboratory findings led to this pilot study's goal of determining the feasibility and efficacy of chromosomal changes to serve as biological indicators of community exposure. Results of the pilot study offered EPA's Health Effects Research Laboratory a new method for defining adverse, long-term effects of "smog" exposure upon healthy individuals.

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ABSTRACT

This research program was initiated with the overall objective of determining whether or not photochemical air pollutants have the potential to cause chromosome breakage in environmentally exposed individuals; if so, could chromosomal changes be used as a biological indicator of exposure to certain environmental conditions in the Los Angeles, California, Basin.

Two hundred fifty-six (256) incoming Freshmen students at the University of Southern California were selected, matched, and grouped by home address into in-basin males and females, and out-of-basin males and females. Blood samples were collected from the selected students at the following times: October 1974 (256 students); February 1975 (237 students); May 1975 (230 students); October 1975 (200 students); and May 1976 (random sample of 68 students). All samples were cultured in the Los Angeles Laboratory and coded for analysis. All slides were analyzed at the Utah Biomedical Test Laboratory, in a double blind fashion, with 100 cells per student per sampling time being scored. All 100 cells were analyzed for chromosome and chromatid aberrations; however, only 25 cells of this 100 were counted for aneuploidy.

Additional blood samples were collected (68 students) for a comparison of satellite association, as well as for rescanning the first three sampling periods on the original group, in order to determine the overall reliability of standard scoring procedures with a large scale study such as this one.

Overall, in-basin males had significantly more abnormal cells, breaks, and gaps than out-of-basin males. Females showed the same trends but only for abnormal cells were the results borderline statistically significant. Differences between in- and out-of-basin students were more pronounced at both October evaluations than at the February and May evaluations.

Chromosome abnormalities in general showed increases from October 1974 through May 1975 and then decreased by October 1975. These changes over time followed similar trends in the levels of carbon monoxide and nitrogen oxides with a lag of four months and followed similar trends in ozone levels with a lag of eight months.

Satellite association variables showed no consistent differences between in- and out-of-basin students nor among sampling periods.

This report was submitted in fulfillment of Contract No. 68-02-1730 by Utah Biomedical Test Laboratory under the sponsorship of the United States Environmental Protection Agency. This report covers the period 1 July 1974 to 21 March 1978, and work was completed as of 30 June 1977.

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ACKNOWLEDGEMENTS

We gratefully acknowledge the helpful cooperation of Dr. Addie Klotz, Director of the Student Health Center at the University of Southern California in Los Angeles, California, and her capable staff in soliciting the cooperation of both the students and the University for this study.

Dr. Dorothy Calafiore, the Project Officer, gave exceptionally valuable assistance and advice in the review of this report. We also acknowledge the assistance given by the personnel of the EPA Exposure Assessment Branch in abstracting pertinent information from the National Aerometric Data Bank-Storage and Retrieval of Aerometric Data which allowed better classification of out-of-basin students in relation to their Los Angeles Basin exposure.

Finally, without the invaluable technical assistance of the following staff at Utah Biomedical Test Laboratory, this project could not have been realized: Richard J. Voss, Larry A. Castle, M. Ina Jordan, Sandra M. Stark, Catherine A. Thornes, and Christiane F. Egleston.

INTRODUCTION

A. Background

In recent years, there has been increasing concern about the mutagenic potential of a wide variety of drugs and chemicals to which the public is exposed. Chromosomal aberrations are a frequent and significant cellular response of individuals who are exposed to certain environmental pollutants that are mutagenic. Recently, there has been increased concern expressed that the inhalation of ozone by man might be mutagenic, the reason being that high ambient ozone concentrations in some of our larger cities and certain industrial situations where large number of individuals are exposed daily. Recently published data have shown the mutagenic effect of ozone in the form of chromosomal breakage, in circulating lymphocytes of Chinese hamsters exposed to doses of 0.2 ppm for 5 hours [1,2,3,4]. McKenzie found no significant increase in the incidence of chromosomal aberrations in cultures of human lymphocytes from healthy male volunteers before and at various intervals after inhaling 0.4 ppm ozone for 4 hours [5]. The present maximum recommended industrial level for occupational exposure is 0.1 ppm per hour for a 40-hour work week [6]. Zelac et al. [3,4] calculated that a 1-week exposure to ozone at this level would produce chromosomal aberrations in lymphocytes at a magnitude six orders greater than that expected from the permitted average radiation exposure over the same period of time. These observations have generated some concern due to the fact that human populations are exposed to photochemical smog pollution at the same level as the Chinese hamsters' exposure. Merz et al. [7] reported a significant increase in chromatid-type aberration from six subjects who were exposed to 0.5 ppm of ozone for 6 and 10 hours during pulmonary function studies. These observations differ with those of Zelac et al. [3,4] who reported chromsome-type aberrations. However, the more recent data of Merz et al. [7] agree qualitatively with those of Fetner [2], who reported the effects of ozone on cultures of human fibroblast cells. Gooch et al. [8] recently confirmed that exposure of cultures to high levels of ozone increased the frequency of chromatid-type aberrations, thus agreeing, qualitatively, with the data of Merz et al. [7] and Fetner [2].

This type of genetic damage is significant from the standpoint of inherited human diseases. Evidence is now convincing that populations with increased levels of chromosomal aberrations, from whatever source, are at an increased risk in terms of the development of some forms of malignant diseases [9,10,11,12]. Chromosomal aberrations detected in an individual's cultured lymphocytes, and the level of his *in vivo* exposure to the given chemical agent being specifically tested may be complicated by other environmental contaminants and/or factors, making it difficult to clearly associate these aberrations with the development of malignancy. For the purposes of monitoring and surveillance of new or undetected environmental hazards, longitudinal and cross-sectional studies of certain sub-populations should be considered. No such data exist at present, although present day technological means to carry out such studies are available. Data from additional well-designed studies are needed; for example, studies in groups with previous or current exposure to prescribed and unprescribed drugs, diagnostic or therapeutic radiation exposure, and viral infections are indicated. It is, therefore, particularly important to collect adequate data for each individual with regard to age, sex, occupational history, radiation and drug histories, exposure to toxic substance, e.g., organic solvents, insecticides.

B. Scope of Work

As part of the Environmental Protection Agency's (EPA) multi-disciplinary approach to protect man and his physical environment from the adverse effects of a great variety of pollutants endangering the purity of air, water, and land today, the Utah Biomedical Test Laboratory (UBTL), a division of the University of Utah Research Institute (UURI), has been engaged in a four-year program under EPA sponsorship. The purpose of this program was to determine the chromosome breaking potential of photochemical pollutants in humans and to assess the efficacy of observed chromosome changes as biological indicators of exposure. To accomplish these goals, 256 incoming Freshman students at the University of Southern California in the Los Angeles Basin were studied initially for development of structural chromosomal damage while attending the University.

A summary of our progress toward fulfilling the contractual aims for this study follows.

1. First Year Phase: Two hundred fifty-six (256) incoming Freshmen students were selected, matched, and grouped into in-basin males and females, and out-of-basin males and females. Blood samples were collected from the selected students at the following times: October 1974, 256 samples; February 1975, 237 samples; May 1975, 230 samples. All samples were cultured in the Los Angeles laboratory and coded for analysis. All slides were analyzed at UBTL, in a double blind fashion, with 100 cells per student per sampling time being scored. The data from a total of 72,800 cells were punched onto computer cards.

2. Second Year Phase: Two hundred (200) blood samples were collected during October 1975 and an OMB-approved questionnaire was administered to 200 students to obtain personal background information, both past and present. Sixty-eight students were randomly selected and slides were reread for the sampling periods of October 1974, February 1975, and May 1975, and are referred to as the rescan group.

3. Third Year Phase: Sixty-eight (68) blood samples were collected from the rescan group during May 1976 and analyzed for both chromosome breakage and satellite association.

4. Fourth Year Phase: A complete cross-sectional and longitudinal analysis of all data collected was completed.

By prolonged follow-up of continuously exposed individuals, the present study collected data which allow one to better quantitate the cytogenetic risks of chronic exposure to photochemical pollutants in the Los Angeles Basin.

CONCLUSIONS

Overall, males whose home addresses were within the L. A. Basin had significantly more abnormal cells, breaks, and gaps than males from outside the L. A. Basin. Females showed the same trends but for only abnormal cells were the results borderline statistically significant. Differences between in- and out-of-basin groups were more pronounced at both October evaluations than at the February and May evaluations. Chromosome abnormalities in general showed increases from October 1974 through May 1975 and then decreased by October 1975. Males did not differ from females with regard to the occurrence of chromosome abnormalities.

In-basin and out-of-basin groups were comparable with regard to most of the background variables. Variables for which there were differences did not correlate with the presence of chromosome abnormalities.

Satellite association evaluated on the rescan group for nine parameters showed no consistent differences among groups or time periods. Females showed more two and three chromosome associations and more associations involving G chromosomes than did males.

Carbon monoxide levels and, to some extent, nitrogen oxide levels correlated positively with chromosome abnormalities, assuming a four-month lag between exposure and sample collection. Ozone correlated negatively with chromosome abnormalities assuming a four-month lag and positively assuming an eight-month lag.

The results of this study support the hypothesis that chromosome abnormalities are related to living in the Los Angeles Basin; however, chromosomal changes do not seem to be an extremely sensitive indicator to environmental air pollution exposure, especially when the type of pollutants at fault and mechanisms of action are not known.

RECOMMENDATIONS

Future investigations should seek to restrict more fully the subjects utilized for in- and out-of-basin groups. Although the present groups were well-defined, some in-basin and out-of-basin students most likely overlapped each other with regard to pollutant exposure. Students also did not always return home or stay in one place during the summer months. The out-of-basin groups should be composed of subjects having lived the last several years in a relatively pollution-free environment and in-basin students should have spent a like amount of time in the polluted environment. Only subjects returning to their homes or a like environment for the majority of the summer should be included. Subjects from areas bordering the polluted area should not be used as out-of-basin subjects. If the above types of study groups are feasible (our experience seems to indicate that this is possible at a large university such as U.S.C.), then a sample size of 200 subjects should be adequate to evaluate major chromosome abnormality changes.

Utilizing such restricted groups from the present study (approximately one-half to two-thirds of the subjects) a follow-up study of these students and their reproductive history should be conducted at some time in the future. This would provide additional information on genetic damage and could be completed through the use of a questionnaire.

The significance of the time lag, as observed in this study, between the exposure of the student and his subsequent development of chromosomal abnormalities deserves further investigation. This basic research should be directed toward the validation and quantification, if possible, of the relationship of the exposure to that of the chromosomal abnormalities observed.

MATERIALS AND METHODS

A. Selection and Classification of Subjects

The University of Southern California (USC) was selected as the site for this study because of its central location in the Los Angeles Basin and its relatively high exposure to the basin air pollutants. Male and female study subjects were chosen from incoming Freshmen students at the University of Southern California Campus. One hundred twenty-eight (128) males and 128 females were selected and coded according to classification criteria given below. No subject selected in this study was known to have an acute illness, although many of the individuals were taking daily medications (both prescribed and over-the-counter), e.g., birth control pills, diet tablets, and aspirin. Also, many drank coffee and/or tea and several would occasionally use alcoholic beverages at social gatherings. A questionnaire was used to obtain both personal and medical information regarding their summer employment, travel, and any toxic substance(s) to which they might have been exposed (see Appendix A).

The Los Angeles Basin was roughly defined to be an area within approximately a thirty-mile radius of downtown Los Angeles. Subjects whose home addresses were within this radius were classified as in-basin, while those outside the boundaries were considered out-of-basin. A list of home addresses of study subjects is given in Appendix B.

Few continental United States communities equal or exceed the oxidant pollution levels frequently recorded in the Los Angeles Basin. To eliminate the possibility, however, that some out-of-basin subjects may have had previous exposure equal to that of in-basin subjects, the pollution levels associated with the home addresses of out-of-basin subjects were evaluated.

For this purpose, California Air Resources Board (CARB) 1974 oxidant measurements were examined for those subjects who lived in California but in communities outside the L. A. Basin. For students coming from out-of-state homes, National Aerometric Data Bank-Storage and Retrieval of Aerometric Data (NADB-SAROAD) were used. The NADB-SAROAD data examined consisted of Annual Frequency Distributions for 1973-1974 and Quarterly Frequency Distributions for 1975 and 1976. When several monitoring sites were available in a given city, a few were selected to estimate the pollution level for that city. For several home addresses where no SAROAD data were available, the data for the closest monitoring sites were used. For example, Chicago data were used for Deerfield, Highland Park, and Kenilworth.

These evaluations revealed that, except for three students, the estimated previous oxidant exposure of all out-of-basin subjects was lower, and for most, considerably lower than the exposure of in-basin subjects. The three exceptions included one student from Redlands, California, and one student from Riverside, California, whose homes were outside the defined LA Basin. These subjects were reclassified to the in-basin group. The third exception was a student who had lived in Tucson, Arizona, who was dropped from the analysis because his exposure before coming to California was probably at least equal to that of in-basin subjects; however, it was not considered accurate to classify him as an in-basin subject.

B. Specimen Collection and Preparation

In order to investigate whether or not exposure to photochemical air pollutants is associated with an increased number of chromosomal aberrations, the following times were utilized for obtaining blood samples for analysis:

1. Initial sample was collected as soon as possible after the students arrived for registration (October 1974). Half of the samples were from students who had never lived in the Los Angeles Basin and half were from students whose homes are in the Basin. This initial early sampling date allowed for minimal, if any, influence of photochemical exposure on out-of-basin students.

2. The second sample was drawn shortly after the Christmas-New Year break (February 1975), thus following the end of the "smog season" and allowing for 3 months exposure to elevated levels of oxidants.

3. The third sample was taken at the end of the school year (May 1975), immediately preceding the "smog season".

4. Blood samples were drawn from 200 of the original students after they had returned back to school (October 1975) at the end of summer vacation. During the study, there was an attrition of 56 students, dropping the original number of students from 256 to 200 students.

5. Blood samples were again collected in May 1976 from a randomly selected group of 68 students from the original 256 students studied.

In order to maintain consistency in handling and culturing of blood samples, collection was accomplished in a laboratory on campus at the Student Health Center for all sampling periods. Following collection, the culturing of these blood samples and preparation of the slides were immediately completed in the same laboratory as follows.

Forty-eight hour lymphocyte cultures were prepared from whole blood [13] collected in a syringe containing 0.1 cc of sterile heparin solution. The culture medium consisted of BBL media that contained 10% fetal calf serum with 1% phytohemaglutinin as the mitogenic agent. Colchicine was added to the cultures 2 hours before harvesting. Potassium chloride was used as the hypotonic agent, the cells were fixed in acetic alcohol and stained with giemsa.

C. Methods of Chromosome Analysis

Slides were randomized, coded, and scored blind at 1000X magnification. All 100 cells were analyzed for chromsome and chromatid aberrations; however, only 25 cells of this 100 were counted for aneuploidy. The following table summarizes the number of samples counted at each sampling period. Appendix C presents an individual summary of samples counted.

Summary of Samples Counted by Subject Classification

	10/74	2/75	5/75	10/75	5/76	Total
In-Basin Males	64	58	55	47	16	240
In-Basin Females	65	65	65	55	17	267
Out-of-Basin Males	64	58	55	49	18	244
Out-of-Basin Females	63	56	55	49	17	240
Total	256	237	230	200	68	991

The method of chromosome analysis was as follows: a metaphase cell was determined suitable by scanning with the low power objective prior to using the oil immersion objective. For purposes of documentation and verification, the number of aneuploid metaphases and the occurrence of structural chromosome and chromatid aberrations, including breaks and fragments, were carefully recorded (see Appendix D). In addition to the number of chromosomes, observations were made on the number of acrocentric chromosomes with satellites associating and the frequency at various time periods for the rescan group (see Appendix E).

For purposes of data analysis, the term "abnormal cells" includes all cells containing breaks, isochromatid breaks, fragments, isofragments, translocations, dicentrics, tricentrics, pericentric inversions, rings, isodeletions, polyradials and endoreduplications. Because chromatid breaks were observed to be the most common abnormality in this study, they were not only included in the classification of abnormal cells but were analyzed separately as well. Therefore, this separate category of chromatid breaks includes isochromatid breaks, fragments and isofragments.

Gaps were scored separately and cells with gaps were not included in the number of abnormal cells. A gap was defined as a complete interruption of the continuity of one or both chromatids not clearly exceeding the width of a chromatid. However, if the discontinuity was larger than the width of a chromatid, the aberrations was scored as a break. Isogaps and isobreaks were scored as single aberrations and so were breaks of the delayed isolocus type. Whenever the following conditions existed, an aberration was scored as a single type chromatid break and not as a chromosome type aberration: 1) an acentric fragment in a metaphase spread, 2) a diploid chromosome count, and 3) whenever it appeared that the fragment was derived from an isobreak in the same spread.

Stable changes, endoreduplications, and aneuploid cells (hyperdiploid and hypodiploid) were also recorded.

D. Measurement of Air Pollutants

Pollutant measurements in the Los Angeles Basin are continuously recorded by the County of Los Angeles Air Pollution Control District. For the period encompassing the study, measurements were obtained from the downtown Los Angeles Station, Number One, located at 434 South San Pedro Blvd., which is approximately three miles northeast of the USC campus center. Data on ozone, carbon monoxide, oxides of nitrogen, sulfur dioxide, hydrocarbons, and particulates were obtained to be used in correlating exposure to air pollutants with chromosome abnormalities. For the purposes of correlation, the monthly averages of one-hour readings were deemed the most representative of pollutant levels.

Methods of pollutant measurement as given by the L. A. Air Pollution Control District are as follows:

1. Ozone (O_3)(KI Method)(More correctly referred to as Oxidant)

   The ozone analyzer utilizes a continuous air-liquid contacting device to absorb the ozone from the air. It measures the ozone by means of a chemical reaction involving the release of iodine from a potassium iodide solution. The amount of iodine released is proportionate to the ozone concentration. The depth of color of the iodine is measured by a colorimeter and is recorded electrically.

2. Carbon Monoxide (CO)

   The CO analyzer measures the concentration of carbon monoxide by means of infrared light absorption principles. The light absorption responses are converted to electric signals for recording.

3. Oxides of Nitrogen (NO/NO_2)

   One instrument determines the separate atmospheric concentrations of two contaminants. It employs two air-reagent continuous contacting systems. The NO_2 (nitrogen dioxide) absorbed from the air in the first column reacts with Saltzman's reagent to produce a color, the depth of which represents the NO_2 concentration. The color depth is measured by a colorimeter and is recorded electrically. Potassium permanganate is used to oxidize NO (nitric oxide) absorbed from the air to NO_2, which is taken up in the second column, measured separately in the same manner, and recorded as NO.

4. Sulfur Dioxide (SO_2)

   This analyzer absorbs sulfur dioxide from the air in a wetted column where the sulfur dioxide is oxidized in sulfuric acid, after which the changes in the electrolytic conductivity of the solution are determined and recorded. Reagents used are dilute sulfuric acid and hydrogen peroxide.

5. Hydrocarbons (H_xC_y)

   Total hydrocarbons in the atmosphere are determined by flame ionization. The sample is exposed to a hydrogen flame in an electrostatic field, where the hydrocarbons are ionized. Ions migrating to the electrodes produce a small electric current that is detected and recorded to provide a continuous record of hydrocarbon concentrations. By passing the sample stream through activated carbon part of the time, hydrocarbons other than methane are removed. In this way, the instrument is used to record both total hydrocarbons and methane, alternately. The difference between two successive readings represents non-methane hydrocarbons.

6. Particulates (Km units)

   "Km" values are measurements of the light reflecting (soiling) properties of particulate matter collected on a paper filter. In the instrument, a known volume of air is passed through a separate spot on a filter paper each hour of the day. One Km unit represents that deposit of particulate matter that produces an optical absorbance of 0.1 when a volume of one cubic meter of air is passed through one square centimeter of the filter. Readings are recorded electrically.

E. Methods of Data Analysis

Data from the personal history questionnaire plus summary chromosome abnormalities and satellite association data were transferred to data coding forms, keypunched onto standard computer cards, and entered into computer data files for analysis. Copies of the coding forms and instructions are given in Appendix F.

Comparability of the study groups on the personal history variables was evaluated using chi square analysis. Where study groups were not comparable with respect to a particular variable, the responses to that variable within each group were evaluated by chi square analysis to see whether the responses were related to the presence of cell abnormalities.

Cell aberrations and satellite association parameters were analyzed using an analysis of variance for a repeated measures design, which tests for differences among groups, among sampling periods, and for consistency of group differences over the sampling periods (group by period interaction). Data were analyzed as a percent of possible occurrences and the percentage was transformed by the Freeman-Tukey transformation [14] before analysis. The transformed values were used in the calculation of statistical significance but arithmetic means are utilized in the presentation of summary figures and tables.

The Freeman-Tukey transformation takes the observed number of occurrences x, the sample size n (number of cells or number of possible occurrences), and transforms to Θ in degrees using the relationship

$$\Theta = 1/2\ [\text{arc sin} \sqrt{x/(n+1)} + \text{arc sin} \sqrt{(x+1)/(n+1)}]$$

The efficiency in reducing heterogeneity of variance can be seen by comparing the standard deviations of the transformed values and untransformed values as given in this report. For cell abnormalities, the transformation worked well; many significant findings would be masked without its use. For satellite association, the heterogeneity of variance of untransformed values was small so the use of the transformation gave only a slight increase in accuracy.

Standard pairwise multiple comparison procedures for repeated measures analysis [15] were used to evaluate in-basin versus out-of-basin differences at each time period for males and females separately. Duncan's multiple range test [16] was used to test for pairwise differences among sampling periods and orthogonal contrasts tested overall group and sex differences.

The differences between the original scans and rescans for the rescan group at each of the first three sampling periods were analyzed using paired t-tests. Correlation techniques were used to relate mean cell abnormalities with air pollutant concentrations.

RESULTS OF DATA ANALYSIS

A. Personal History Analysis

Appendix G presents tables of distributions of personal history variables tabulated by study group. Within each sex, the in-basin and out-of-basin groups of students were comparable for all variables except for the following statistically significant differences: in-basin males were significantly older than out-of-basin males, but only by one year (median ages 20 and 19 years, respectively). Out-of-basin males were currently taking and routinely took more antihistamines than the in-basin males. In the period from May to October, 1974, out-of-basin males received more tetanus shots than in-basin males. In-basin females had more occurrences of hay fever from October, 1974, to February, 1975, and also reported more allergies to antibiotics than the out-of-basin females. Out-of-basin females reported more x-rays to the lower extremities in the last five years than did in-basin females, while in-basin females reported more x-rays to the trunk. Even though the groups were not comparable on these variables, tables in Appendix H show that there is no relationship between the presence of abnormal cells and age, antihistamines, tetanus shots, hayfever, allergies, or x-rays in the affected groups.

B. Analysis of Cell Abnormalities

The statistical analysis of the cell abnormality parameters was performed on only 199 students because these were the only ones in whom four consecutive samples were available out of the original group of 256. Based on the classification of chromosomal aberrations as described on page 8 above, analysis of cell abnormality parameters revealed the following results: For abnormal cells ($p<.10$), breaks ($p<.10$), and gaps ($p<.01$), the in-basin males had significantly higher values than out-of-basin males in October, 1974. At the February and May, 1975, evaluations, these two groups were not significantly different. In October, 1975, the in-basin males again had more abnormal cells ($p=.11$) and breaks ($p<.10$). Over all time periods, in-basin males showed statistically significantly more abnormal cells ($p<.05$), more breaks ($p=.07$), and more gaps ($p<.05$) than out-of-basin males. Females also showed the same trends over all time periods, but the results were not as significant as the male results: abnormal cells ($p=.07$), breaks ($p=.11$), gaps ($p=.15$). These findings are somewhat consistent with the hypothesis that living in the basin is related to chromosome aberrations, if the borderline statistical significances ($p\simeq.10$) and only male results are considered. The in-basin females had more gaps and isogaps than out-of-basin females ($p<.10$) at the beginning of the study, but no significant differences were evident during the other three sampling periods. No differences between in- and out-of-basin students were found for aneuploid cells or stable changes. At the May 1975 evaluation, both in-basin groups had more endoreduplications than the out-of-basin groups ($p<.01$) but these differences were not evident at any other time. Endoreduplications and stable changes occurred infrequently. For all cell abnormalities, no differences were observed between males and females.

Statistically significant time trends over the four sampling periods were found for all study groups. For abnormal cells, breaks, gaps, hyperdiploid cells, and hypodiploid cells, the October 1974 values were the lowest; February 1975 showed a significant increase over the previous October; and May 1975 gave the highest values, significantly greater than February. By October 1975, values for gaps had been reduced to the October 1974 levels and values for the other four parameters dropped to the February 1975 levels. Isogaps were constant over the first three sampling periods and then dropped significantly in October 1975. Endoreduplications were higher in May 1975 than at any of the other times and stable changes peaked in October 1975, after remaining somewhat constant for the first three periods. Figures 1 to 8 (at the end of this section) present mean levels over time, along with the means and standard deviations of the untransformed data. The results of the analysis of variance are given in Appendix I for transformed data.

C. Analysis of Rescan Data

The rescan group, composed of a random sample of 68 of the original 200 subjects, was re-evaluated for abnormalities using duplicate slides for the first three sampling periods. Table 1 summarizes the differences between the two scans. Of importance is that statistically significant differences were found between the two scans for most of the variables; however, the differences were distributed equally among the four study groups, so all intergroup comparisons are still valid. Differences among the sampling periods as described earlier were generally of larger magnitude than the differences between the two scans; the trends should be similar but would change according to the rescan differences. More accurate time trends can be seen by looking at only the rescan group data.

The rescan group was also evaluated for abnormalities at one additional time period, May 1976. Values in May 1976 were generally similar to the October 1975 values. Intergroup differences were somewhat erratic with in-basin females showing overall more abnormal cells, gaps, and isogaps, and in-basin males showing more breaks than their out-of-basin counterparts. Due to the effects of reduced sample sizes in the rescan groups, it is suggested that intergroup differences be evaluated with respect to the original groups. Figures 9 to 16 (at the end of this section) summarize rescan group abnormalities over the five periods using the rescan values for the first three periods; the results of the analysis of variance are found in Appendix J. Trends depicted in these figures are more variable due to fewer subjects but are likely more representative of real time trends due to the differences between original scans and rescans. For abnormal cells, breaks, and gaps, females showed statistically significantly larger values than males, a finding not shown in the analysis of original scans. This is basically due to large values in the in-basin

TABLE 1. Comparison of Rescan and Original Scan, Frequency Distributions of Differences

Variable	October 1974	February 1975	May 1975
No. of Abnormal Cells			
Rescan greater	26	29	18
No difference	31	28	28
Rescan less	11	11	22
Mean Difference in Count	0.4	0.4*	-0.2
Breaks			
Rescan greater	27	30	24
No difference	34	26	25
Rescan less	7	12	19
Mean Difference in Count	0.7***	0.7**	-0.1
Gaps			
Rescan greater	37	30	22
No difference	19	12	4
Rescan less	12	26	42
Mean Difference in Count	0.6**	-0.1	-1.0***
Isogaps			
Rescan greater	5	2	10
No difference	52	53	40
Rescan less	11	13	18
Mean Difference in Count	-0.3*	-0.2**	-0.2*
Hyperdiploid			
Rescan greater	19	5	3
No difference	48	41	42
Rescan less	1	22	23
Mean Difference in Count	0.8***	-0.8*	-2.0***
Hypodiploid			
Rescan greater	56	42	33
No difference	4	3	5
Rescan less	8	23	30
Mean Difference in Count	6.2***	3.8***	0.4

*, **, *** Statistically significantly different from zero $p<.05$, $p<.01$, $p<.001$.

female group, and may be due to sampling selection.

With regard to the major variables of interest (abnormal cells, breaks, gaps, isogaps), the original scan analyses and rescan analyses both show similar differences between in- and out-of-basin subjects, although not necessarily always statistically significant. The major difference between analyses is in the magnitude of the time trends. Nevertheless, both analyses show the May 1975 levels to be greater than either the October 1974 or October 1975 levels.

D. Analysis of Satellite Association Data

Satellite association was analyzed on the rescan group. Nine parameters were evaluated: Number of D's associated, number of G's associated, groups of two chromosomes, groups of three chromosomes, groups of four or more chromosomes, number of D-D associations, number of D-G associations, number of G-G associations, and number of cells with no associations. These were all analyzed as a percent of the total possible occurrences. There were no consistent differences between in- and out-of-basin students. In February 1975, the in-basin males had more groups of three associations than the out-of-basin males and in May 1975, the in-basin females had more groups of four or more associations than out-of-basin females. There were no consistent time trends in any of the parameters over the course of the study. October 1975 evaluations gave the highest values for most of the parameters. This does not correspond to the time trends for cell abnormalities. Figures 17-25 (at the end of this section) present mean values and Appendix K gives the analysis of variance results. Overall, females showed more satellite association than males involving G chromosomes and in the number of two- and three-chromosome associations.

E. Analysis of Pollutant Data

The concentrations of six pollutants from the atmosphere were compared with the percentage of abnormal cells, mean number of breaks, mean number of gaps, and percent aneuploid cells. Values for the in-basin rescan groups were used so that the correlations could be calculated over five time periods rather than four and since the rescan values for the earlier times were more consistently scored. Figures 26a and 26b (at the end of this section) show the concentrations of particulates, hydrocarbons, nitrogen dioxide/nitric oxide, sulfur dioxide, carbon monoxide, and ozone over the course of the study. These curves did not correspond to the chromosome abnormality curves of the same time periods but seemed to correlate with the chromosome abnormality curves with a lag of about four months. For each pollutant, four indices of pollutant concentrations, four months prior, were correlated with the above four chromosome parameters. These four indices were: (1) concentration four months prior to chromosome evaluation, (2) mean concentration from three to five months prior, (3) mean concentration for one to four months prior, and (4) peak concentration (minimum for ozone) during months one to four prior. Since ozone was negatively correlated at four months, two additional ozone concentration indices were evaluated, representing an 8-month lag, which gave positive correlations. These indices were (5) concentration eight months prior to chromosomal

TABLE 2. Correlation Coefficients Between Pollutant Concentrations and Chromosome Abnormalities

Pollutant	Concentration Index	% of Cells w/ Abnormalities	Mean Number of Breaks/ Cell	Mean Number of Gaps/ Cell	% Aneuploid Cells
Ozone	1	-.77	-.82	-.68	-.28
	2	-.59	-.60	-.63	-.10
	3	-.87(*)	-.79	-.84(*)	-.56
	4	-.87(*)	-.80	-.81(*)	-.56
	5	.84(*)	.78	.79	.47
	6	.79	.64	.81(*)	.56
Carbon Monoxide	1	.78	.77	.80	.35
	2	.90*	.84(*)	.91*	.57
	3	.84(*)	.67	.82(*)	.90*
	4	.88*	.72	.98**	.78
Sulfur Dioxide	1	.05	-.02	.35	-.29
	2	.49	.40	.60	.07
	3	.36	.16	.40	.79
	4	.32	.26	.35	-.11
Nitrogen Dioxide/ Nitric Oxide	1	.64	.62	.72	.18
	2	.69	.63	.76	.27
	3	.81(*)	.64	.76	.75
	4	.87(*)	.76	.89*	.61
Hydrocarbons	1	.20	.19	.34	-.29
	2	.34	.30	.40	-.14
	3	.49	.43	.36	.15
	4	.37	.39	.25	-.12
Particulates (n=4)	1	.69	.57	.71	.18
	2	.67	.56	.66	.13
	3	.61	.55	.52	.00
	4	.69	.63	.59	.10

(*) Borderline statistically significant correlation $p<.10$
*,** Statistically significant correlation $p<.05$, $p<.01$

Concentration Index
1 = 4 months prior
2 = mean 3-5 months prior
3 = mean 1-4 months prior
4 = peak (minimum for ozone) during months 1-4
5 = 8 months prior - ozone only
6 = peak months 5-8 prior - ozone only

evaluation and (6) peak concentration from five to eight months prior.

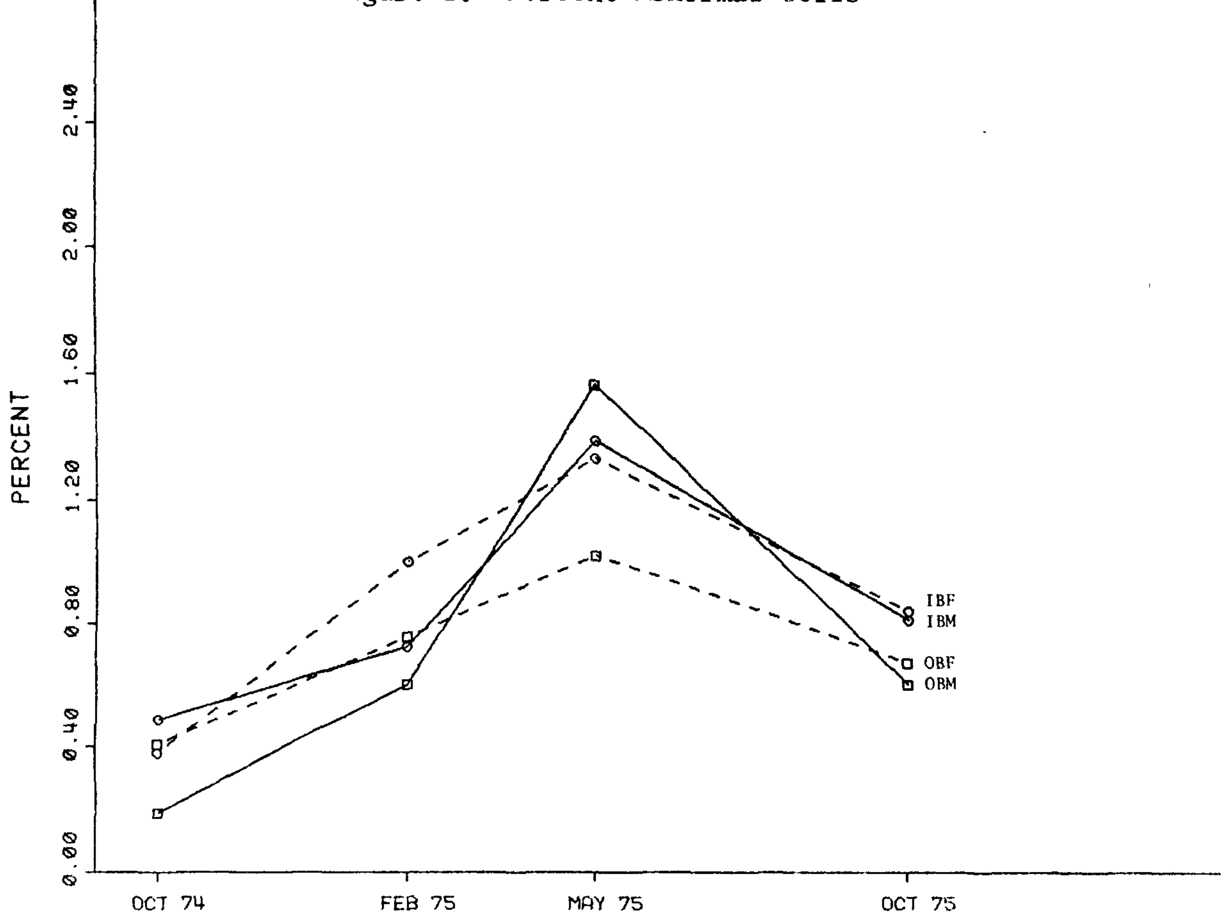
Table 2 presents the correlation coefficients between pollutants and chromosome abnormalities over the five evaluation periods. Carbon monoxide and, to some extent, nitrogen dioxide/nitric oxide gave significant positive correlations and ozone showed significant negative correlations with abnormality variables, assuming a four-month lag between exposure and cell abnormalities. Assuming an eight-month lag for ozone, the correlations of abnormal cells and gaps with ozone were also positive ($p<.10$). These results by no means indicate cause and effect relationships; they are only presented for the purpose of generating hypotheses. Data used in the correlations are given in Table 3.

TABLE 3. Data used in Correlations of Pollutant Levels with In-Basin Group Chromosomal Abnormalities.

Chromosome Variables In-Basin Students (N=33)		Oct 74	Feb 75	May 75	Oct 75	May 76
% Abnormal Cells		0.76	1.30	1.33	0.88	0.97
Mean Breaks/100 Cells		1.15	1.64	1.76	1.42	1.39
Mean Gaps/100 Cells		1.88	2.70	3.00	1.36	2.06
% Aneuploid Cells		10.30	15.88	13.64	9.46	8.42
Pollutant	**Index**					
Ozone (pphm)	1	4.5	3.0	2.0	3.7	2.4
	2	4.1	3.2	1.8	3.9	1.9
	3	4.5	2.2	2.2	4.3	2.5
	4	4.0	1.7	1.8	3.7	2.0
	5	1.3	4.5	4.8	1.8	4.6
	6	3.7	4.8	4.8	3.5	4.6
Carbon Monoxide (ppm)	1	2.9	5.5	8.4	3.3	6.7
	2	3.0	6.2	7.6	3.0	5.9
	3	3.9	7.5	5.5	3.3	4.5
	4	5.6	8.5	8.4	4.1	6.7
Sulfur Dioxide (pphm)	1	2.1	1.6	2.4	1.4	2.7
	2	1.8	2.1	2.3	1.6	2.5
	3	2.0	2.2	1.9	1.8	1.8
	4	2.2	2.4	2.4	2.2	2.7
Nitrogen Oxides (pphm)	1	8.3	16.5	32.1	7.1	28.3
	2	9.3	18.9	27.3	7.3	26.1
	3	9.8	27.2	17.6	8.1	17.7
	4	12.4	32.5	32.1	10.1	28.3
Hydrocarbons (ppm)	1	22.0	21.0	31.6	19.5	37.9
	2	20.7	25.0	28.9	20.5	35.9
	3	22.3	27.9	25.2	24.2	29.1
	4	25.0	31.6	31.6	29.4	37.9
Particulates (Km unit x 10)	1	19.8	--	40.7	18.4	44.8
	2	19.0	--	36.9	19.2	41.8
	3	20.4	--	27.1	22.3	30.0
	4	23.3	--	40.7	28.1	44.8

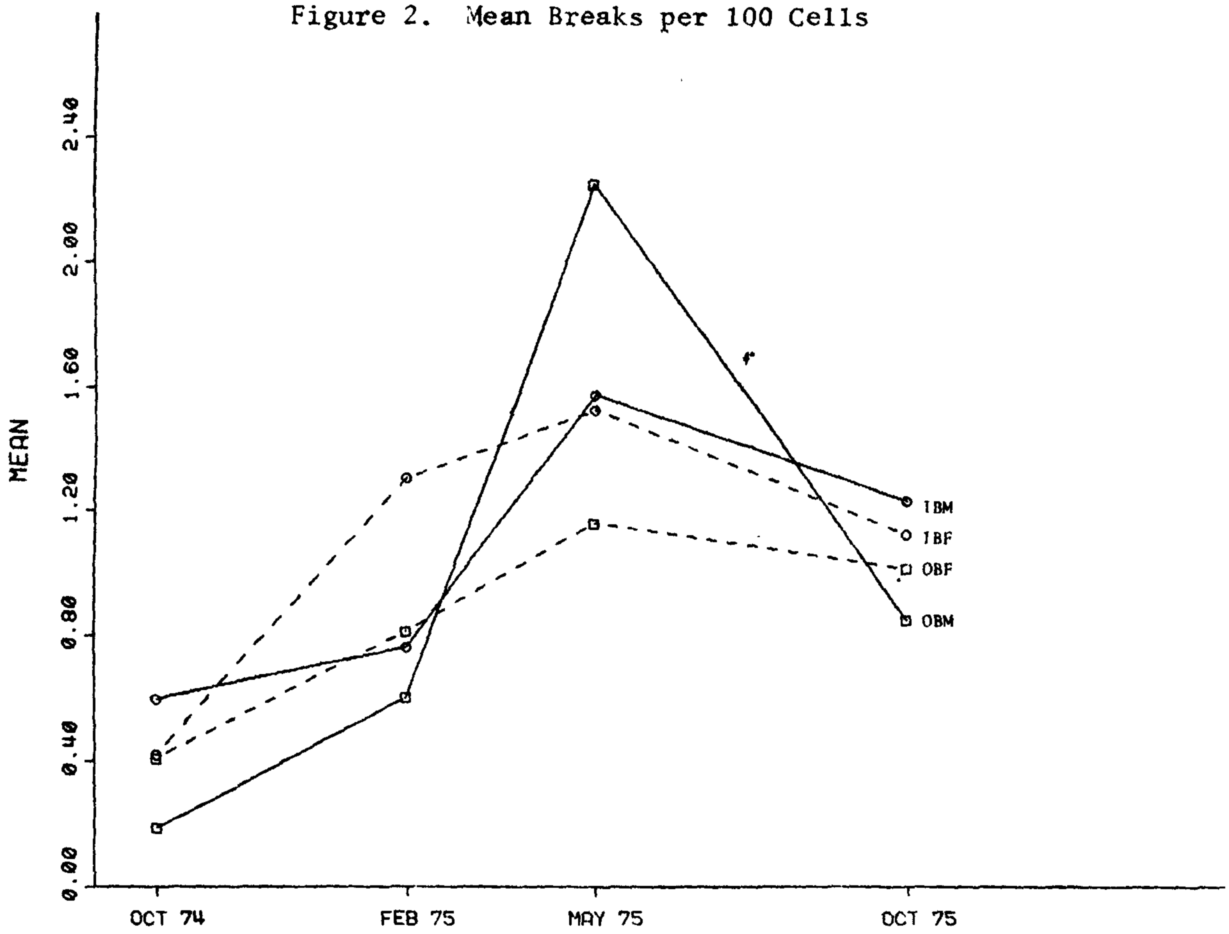
Index	Based on monthly averages of one hour readings
1	4 months prior
2	Mean 3-5 months prior
3	Mean 1-4 months prior
4	Peak (minimum for ozone) during months 1-4
5	8 months prior -- ozone only
6	Peak months 5-8 -- ozone only

Figure 1. Percent Abnormal Cells



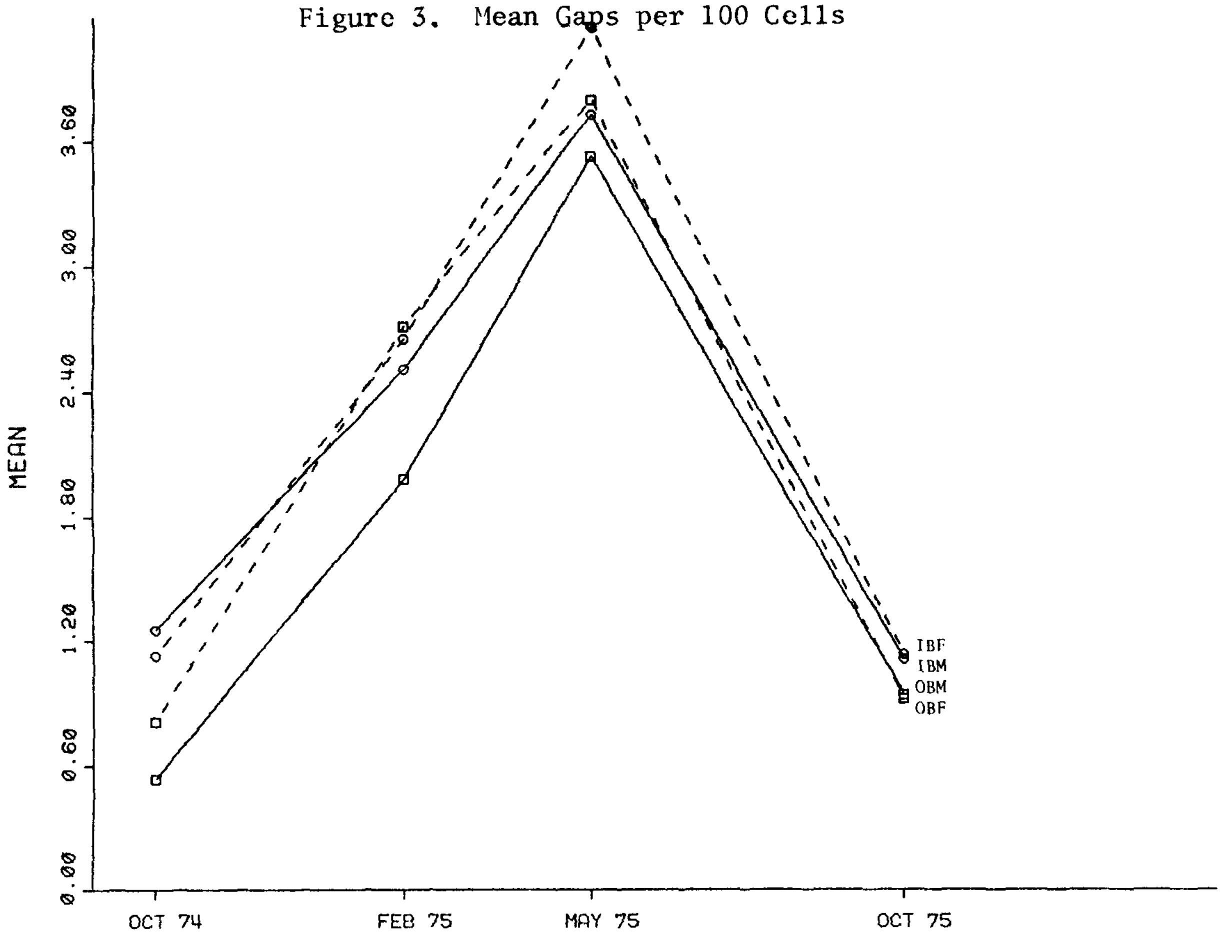
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	.489	.723	1.383	.809	.851
	IN FEMALE	2	55	.382	1.000	1.327	.836	.886
	OUT MALE	3	48	.188	.604	1.562	.604	.740
	OUT FEMALE	4	49	.408	.755	1.020	.673	.714
	TOTAL		199	.367	.779	1.322	.734	.800
Standard Deviations	IN MALE	1	47	.748	1.097	1.153	.900	1.034
	IN FEMALE	2	55	.707	1.186	1.203	.977	1.086
	OUT MALE	3	48	.532	.736	3.228	1.267	1.849
	OUT FEMALE	4	49	1.019	1.011	1.199	.922	1.057
	TOTAL		199	.773	1.031	1.888	1.022	1.295

Figure 2. Mean Breaks per 100 Cells



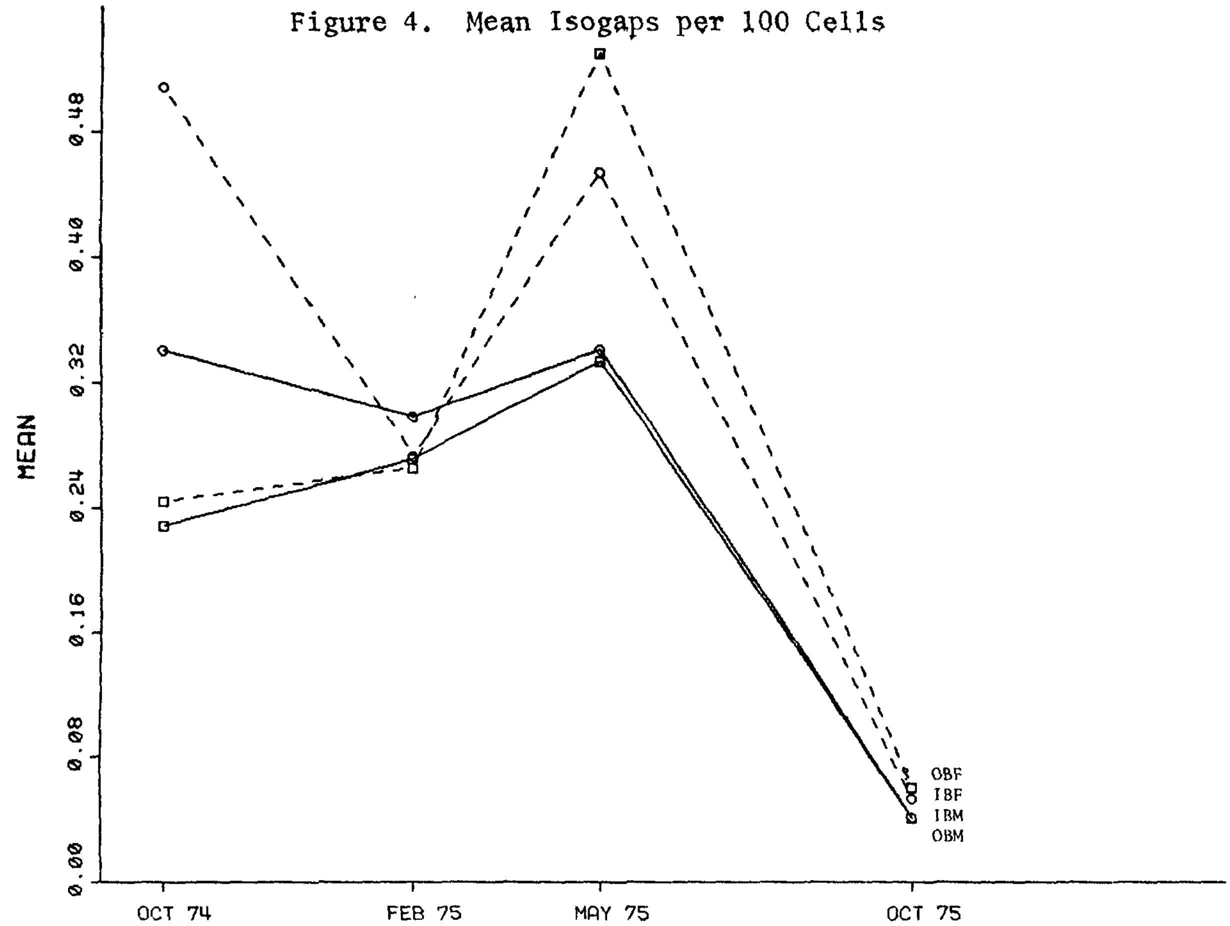
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	.596	.766	1.574	1.234	1.043
	IN FEMALE	2	55	.418	1.309	1.527	1.127	1.095
	OUT MALE	3	48	.188	.604	2.250	.854	.974
	OUT FEMALE	4	49	.408	.816	1.163	1.020	.852
	TOTAL		199	.402	.889	1.623	1.060	.994
Standard Deviations	IN MALE	1	47	1.097	1.146	1.571	1.478	1.383
	IN FEMALE	2	55	.809	2.125	1.665	1.415	1.620
	OUT MALE	3	48	.532	.736	5.778	1.924	3.151
	OUT FEMALE	4	49	1.039	1.202	1.434	1.283	1.270
	TOTAL		199	.898	1.445	3.147	1.533	1.991

Figure 3. Mean Gaps per 100 Cells



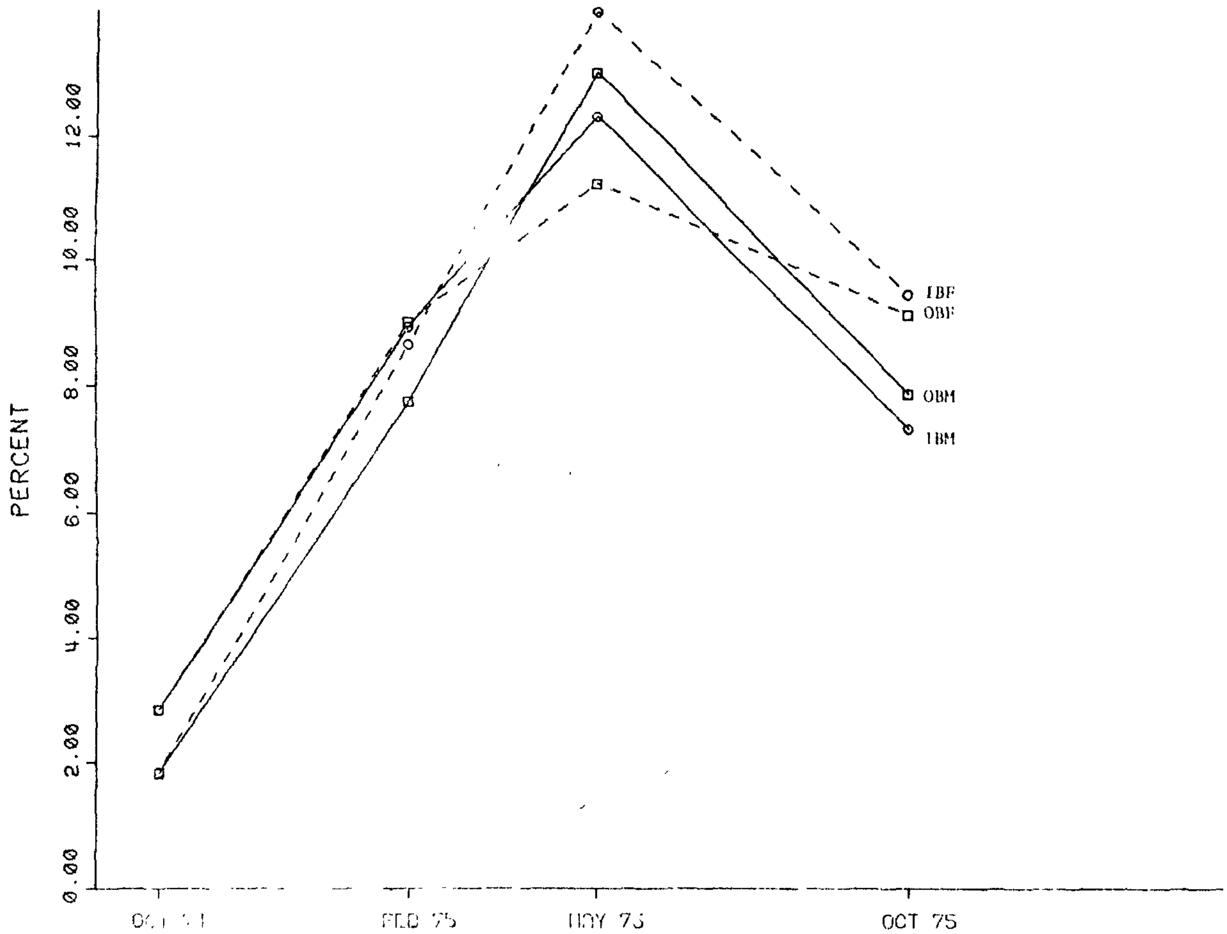
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	1.255	2.511	3.723	1.106	2.149
	IN FEMALE	2	55	1.127	2.655	4.145	1.127	2.264
	OUT MALE	3	48	.542	1.979	3.521	.938	1.745
	OUT FEMALE	4	49	.816	2.714	3.796	.918	2.061
	TOTAL		199	.940	2.472	3.809	1.025	2.062
Standard Deviations	IN MALE	1	47	1.539	2.115	2.050	1.478	2.094
	IN FEMALE	2	55	1.362	2.518	1.890	1.441	2.234
	OUT MALE	3	48	1.031	1.509	2.032	1.040	1.854
	OUT FEMALE	4	49	1.679	2.072	2.217	1.320	2.229
	TOTAL		199	1.438	2.105	2.043	1.327	2.118

Figure 4. Mean Isogaps per 100 Cells



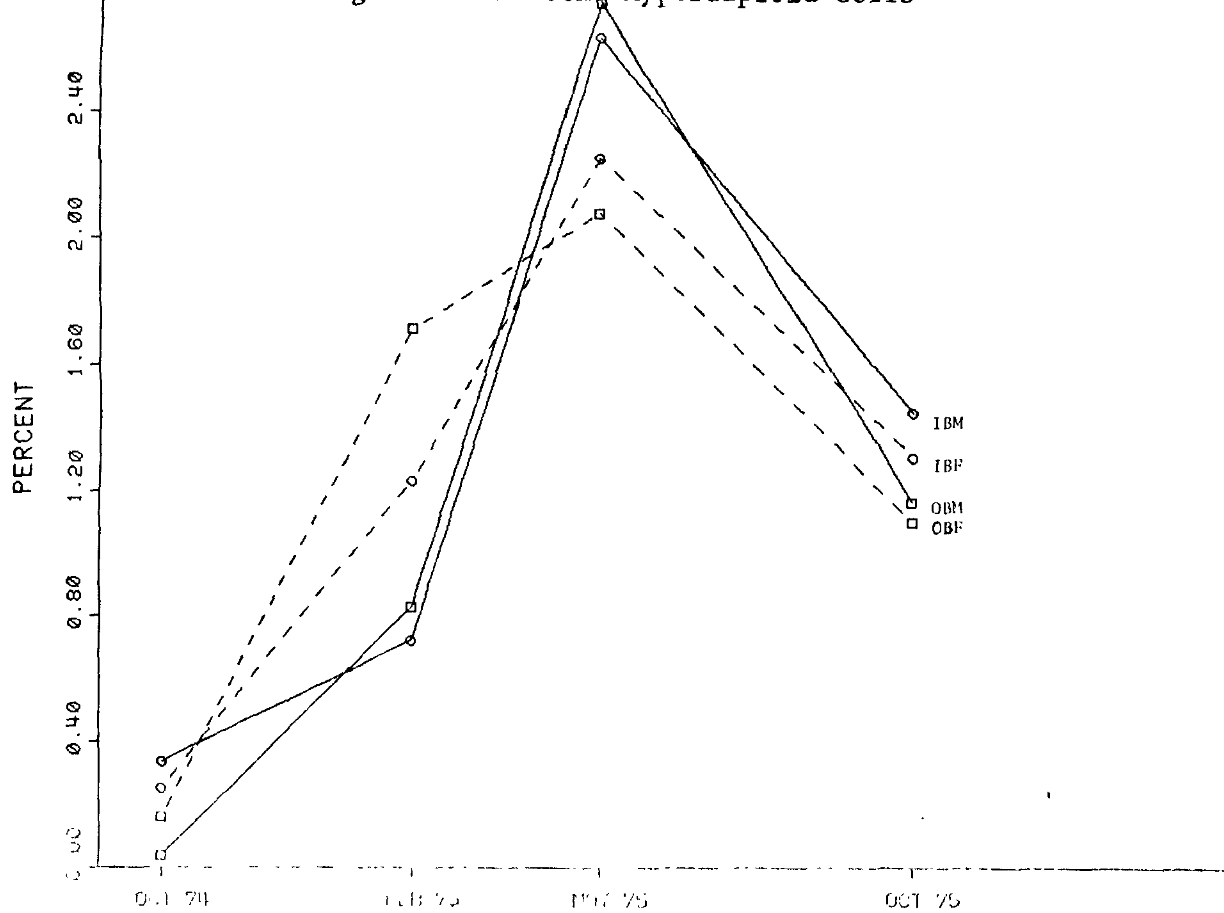
				OCT 74	FEB 75	MAY 75	OCT 75	
	GROUPS:		N	1	2	3	4	TOTAL
Means	IN MALE	1	47	.340	.298	.340	.043	.255
	IN FEMALE	2	55	.509	.273	.455	.055	.323
	OUT MALE	3	48	.229	.271	.333	.042	.219
	OUT FEMALE	4	49	.245	.265	.531	.061	.276
	TOTAL		199	.337	.276	.417	.050	.270
Standard Deviations	IN MALE	1	47	1.006	.587	.867	.204	.738
	IN FEMALE	2	55	.979	.560	.899	.229	.747
	OUT MALE	3	48	.592	.536	.663	.202	.536
	OUT FEMALE	4	49	.630	.605	.767	.242	.612
	TOTAL		199	.830	.568	.805	.219	.666

Figure 5. Percent Hypodiploid Cells



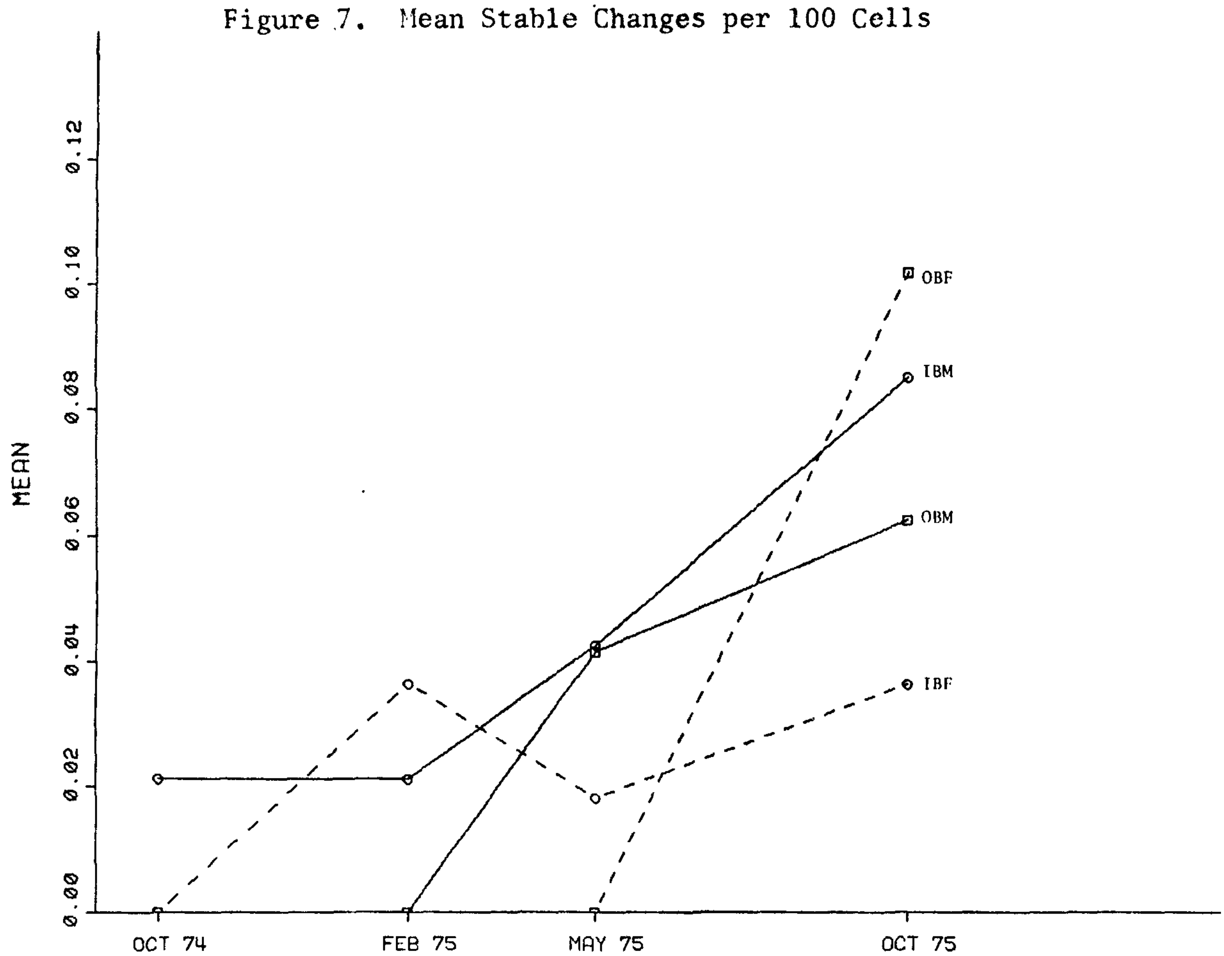
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	2.851	8.936	12.298	7.319	7.851
	IN FEMALE	2	55	1.855	8.655	13.964	9.455	8.482
	OUT MALE	3	48	1.833	7.750	13.000	7.875	7.615
	OUT FEMALE	4	49	2.857	9.020	11.224	9.143	8.061
	TOTAL		199	2.332	8.593	12.663	8.492	8.020
Standard Deviations	IN MALE	1	47	5.544	7.516	8.597	5.247	7.618
	IN FEMALE	2	55	3.027	9.270	8.739	7.195	8.595
	OUT MALE	3	48	5.440	6.596	6.691	5.927	7.305
	OUT FEMALE	4	49	7.958	8.074	6.693	6.429	7.917
	TOTAL		199	5.681	7.933	7.780	6.297	7.893

Figure 6. Percent Hyperdiploid Cells



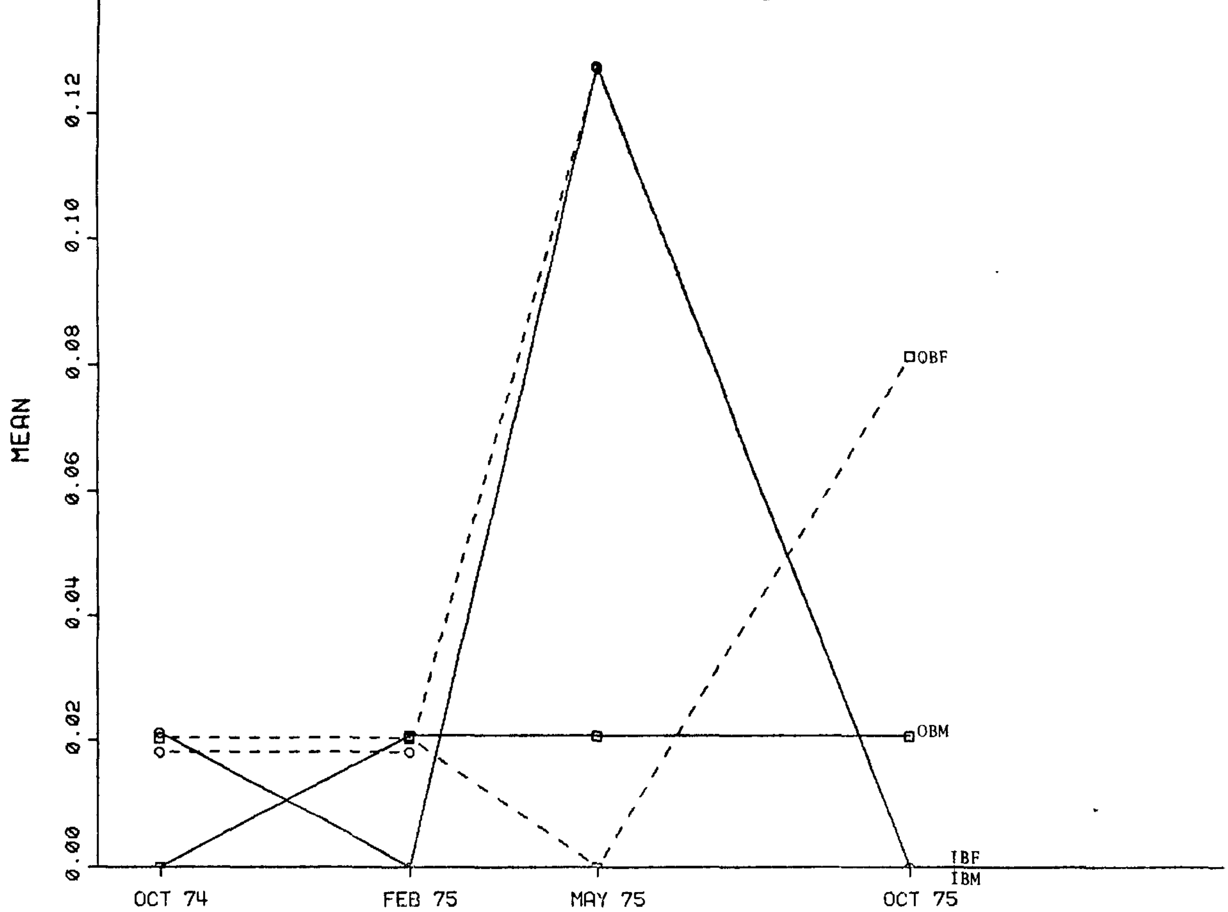
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	.340	.723	2.638	1.447	1.287
	IN FEMALE	2	55	.255	1.236	2.255	1.309	1.264
	OUT MALE	3	48	.042	.833	2.750	1.167	1.198
	OUT FEMALE	4	49	.163	1.714	2.032	1.192	1.265
	TOTAL		199	.201	1.136	2.422	1.256	1.254
Standard Deviations	IN MALE	1	47	1.128	1.410	3.233	2.594	2.408
	IN FEMALE	2	55	.865	2.160	3.632	2.834	2.659
	OUT MALE	3	48	.289	1.837	4.403	2.504	2.887
	OUT FEMALE	4	49	.688	2.646	3.851	1.829	2.616
	TOTAL		199	.804	2.093	3.806	2.464	2.645

Figure 7. Mean Stable Changes per 100 Cells



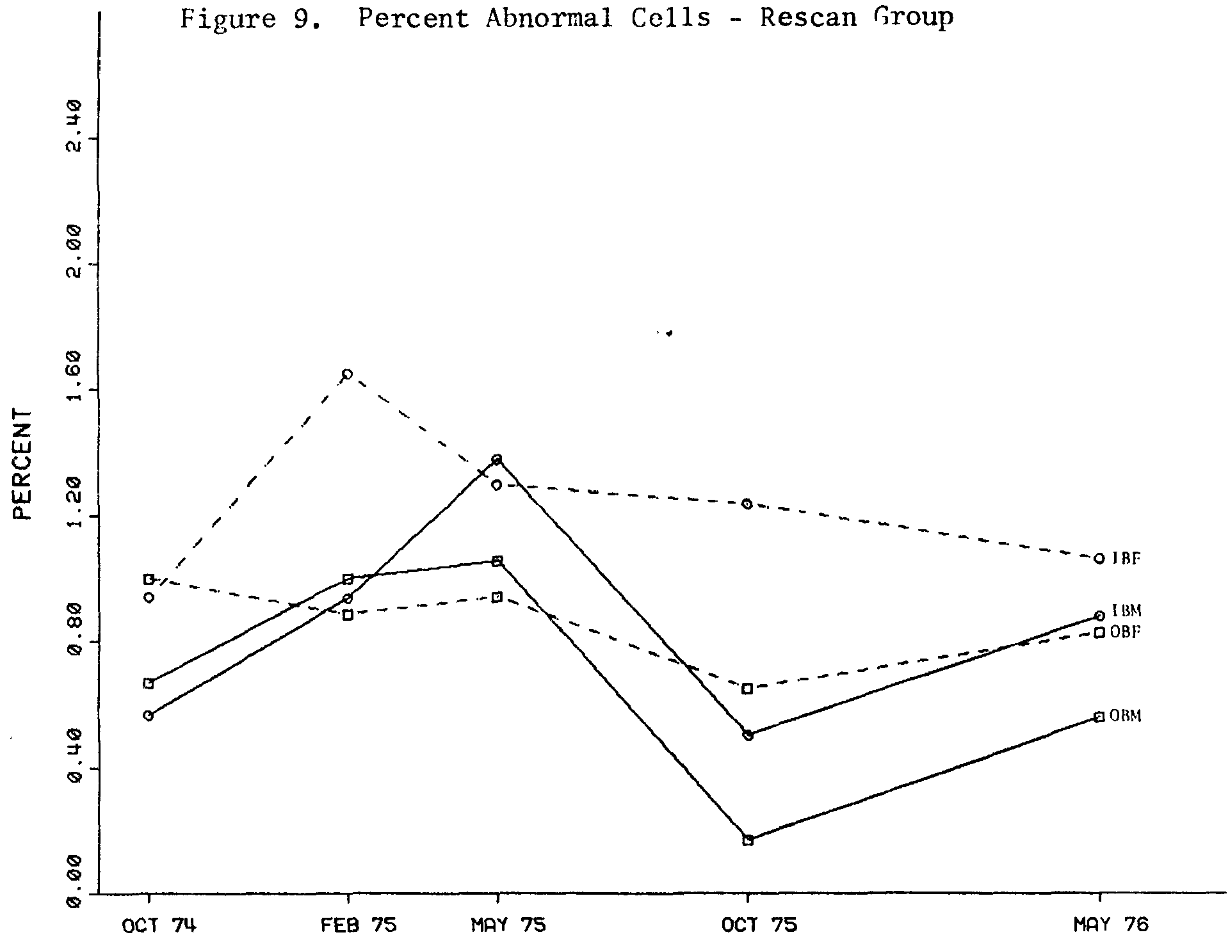
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	.021	.021	.043	.085	.043
	IN FEMALE	2	55	.000	.036	.018	.036	.023
	OUT MALE	3	48	.000	.000	.042	.063	.026
	OUT FEMALE	4	49	.000	.000	.000	.102	.026
	TOTAL		199	.005	.015	.025	.070	.029
Standard Deviations	IN MALE	1	47	.146	.146	.204	.282	.202
	IN FEMALE	2	55	.000	.270	.135	.189	.177
	OUT MALE	3	48	.000	.000	.202	.320	.190
	OUT FEMALE	4	49	.000	.000	.000	.306	.158
	TOTAL		199	.071	.158	.157	.275	.182

Figure 8. Mean Endoreduplications per 100 Cells



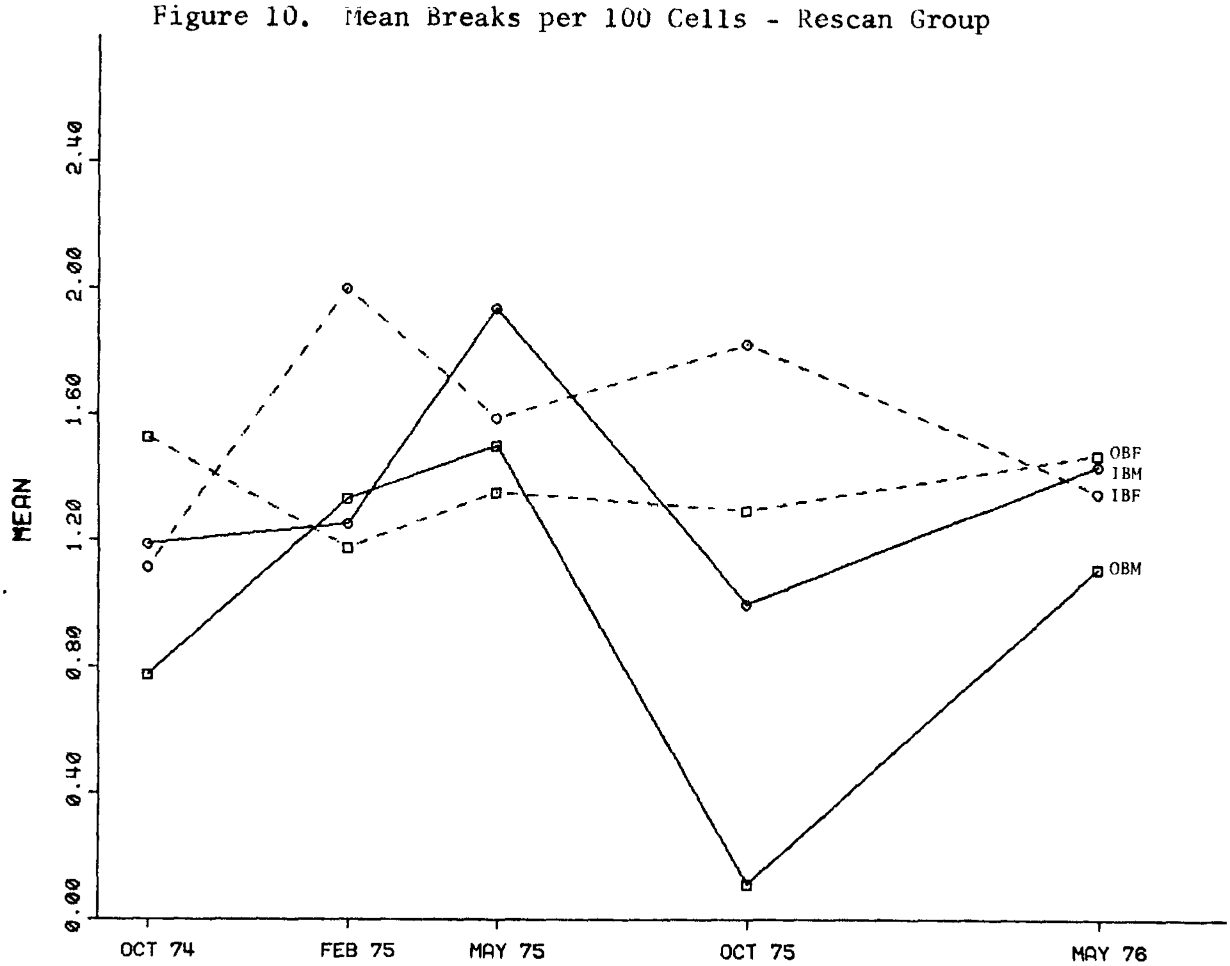
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
Means	IN MALE	1	47	.021	.000	.128	.000	.037
	IN FEMALE	2	55	.018	.018	.127	.000	.041
	OUT MALE	3	48	.000	.021	.021	.021	.016
	OUT FEMALE	4	49	.020	.020	.000	.082	.031
	TOTAL		199	.015	.015	.070	.025	.031
Standard Deviations	IN MALE	1	47	.146	.000	.397	.000	.216
	IN FEMALE	2	55	.135	.135	.336	.000	.199
	OUT MALE	3	48	.000	.144	.144	.144	.124
	OUT FEMALE	4	49	.143	.143	.000	.344	.200
	TOTAL		199	.122	.122	.275	.186	.188

Figure 9. Percent Abnormal Cells - Rescan Group



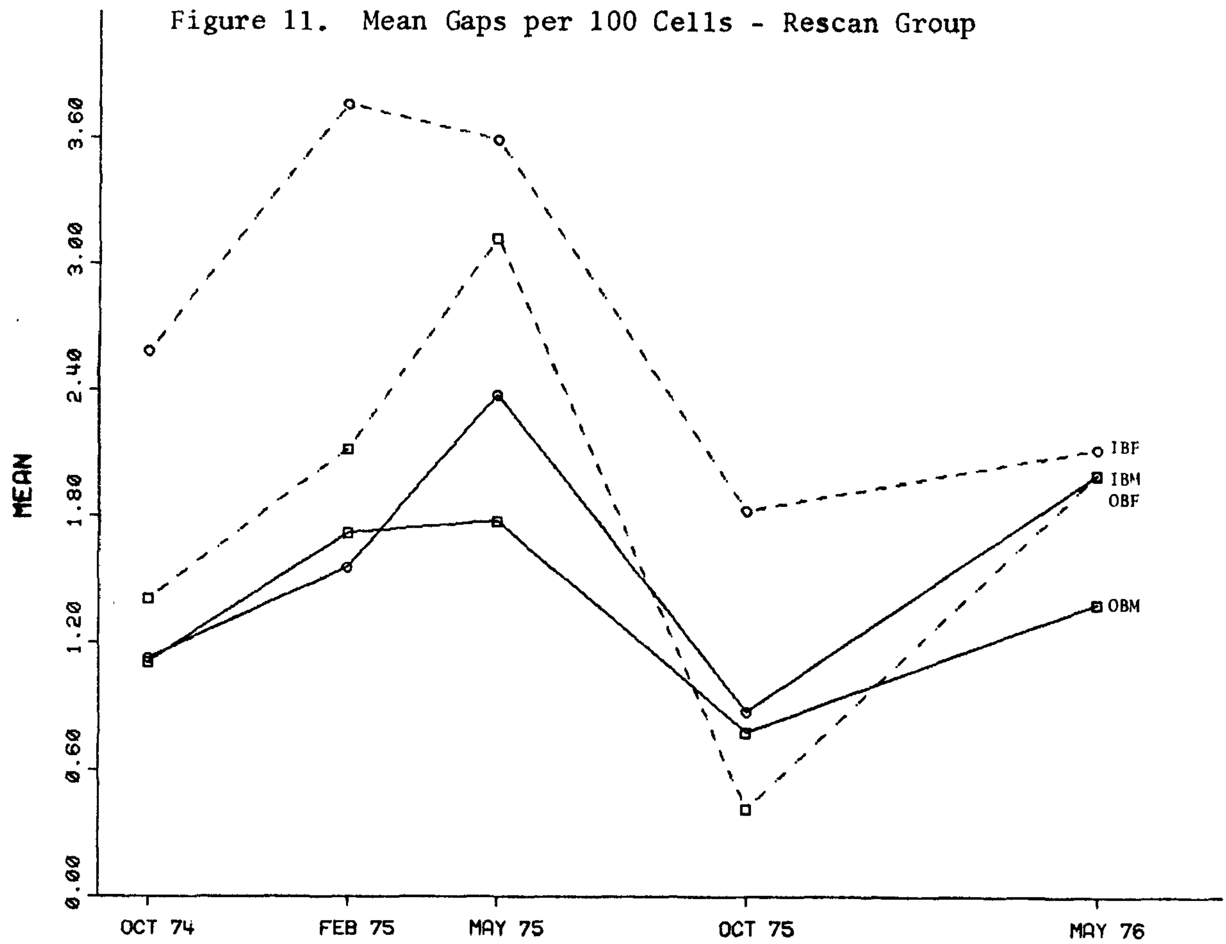
				OCT 74	FEB 75	MAY 75	OCT 75	MAY 76	
	GROUPS:		N	1	2	3	4	5	TOTAL
Means	IN MALE	1	16	.563	.938	1.375	.500	.875	.850
	IN FEMALE	2	17	.941	1.647	1.294	1.235	1.059	1.235
	OUT MALE	3	18	.667	1.000	1.056	.167	.556	.689
	OUT FEMALE	4	17	1.000	.882	.941	.647	.824	.859
	TOTAL		68	.794	1.118	1.162	.632	.824	.906
Standard Deviations	IN MALE	1	16	.814	.998	1.088	.632	1.025	.956
	IN FEMALE	2	17	1.298	1.455	.920	1.200	.827	1.161
	OUT MALE	3	18	.840	1.237	1.162	.383	.856	.979
	OUT FEMALE	4	17	.791	1.166	1.029	.702	.809	.902
	TOTAL		68	.955	1.240	1.045	.862	.880	1.020

Figure 10. Mean Breaks per 100 Cells - Rescan Group



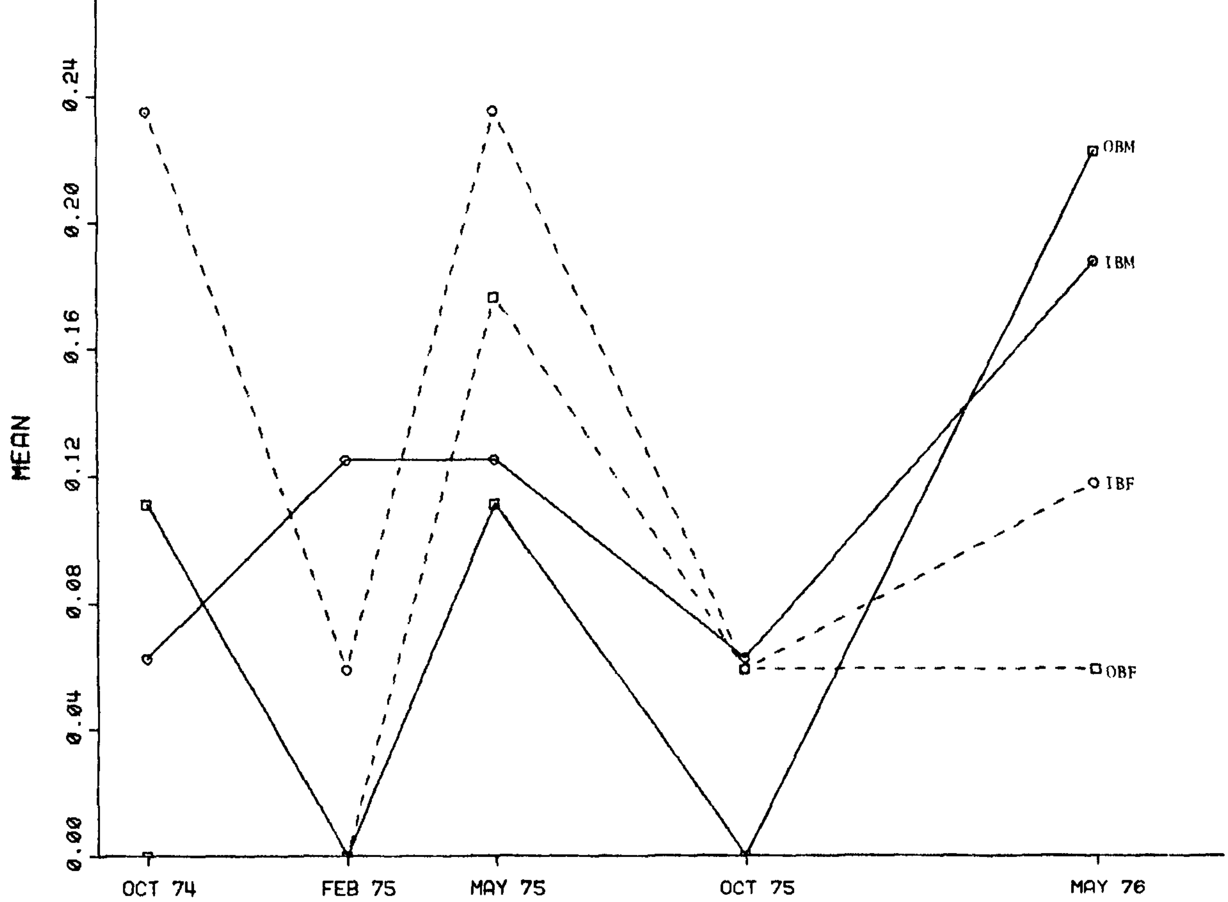
			OCT 74	FEB 75	MAY 75	OCT 75	MAY 76	
	GROUPS:	N	1	2	3	4	5	TOTAL
Means	IN MALE 1	16	1.187	1.250	1.937	1.000	1.437	1.362
	IN FEMALE 2	17	1.118	2.000	1.588	1.824	1.353	1.576
	OUT MALE 3	18	.778	1.333	1.500	.111	1.111	.967
	OUT FEMALE 4	17	1.529	1.176	1.353	1.294	1.471	1.365
	TOTAL	68	1.147	1.441	1.588	1.044	1.338	1.312
Standard Deviations	IN MALE 1	16	2.810	1.438	1.652	1.592	1.711	1.884
	IN FEMALE 2	17	1.536	2.000	1.372	1.912	1.222	1.628
	OUT MALE 3	18	1.003	2.301	1.654	.323	1.811	1.618
	OUT FEMALE 4	17	1.375	1.704	1.272	1.448	1.841	1.511
	TOTAL	68	1.764	1.888	1.479	1.540	1.636	1.670

Figure 11. Mean Gaps per 100 Cells - Rescan Group



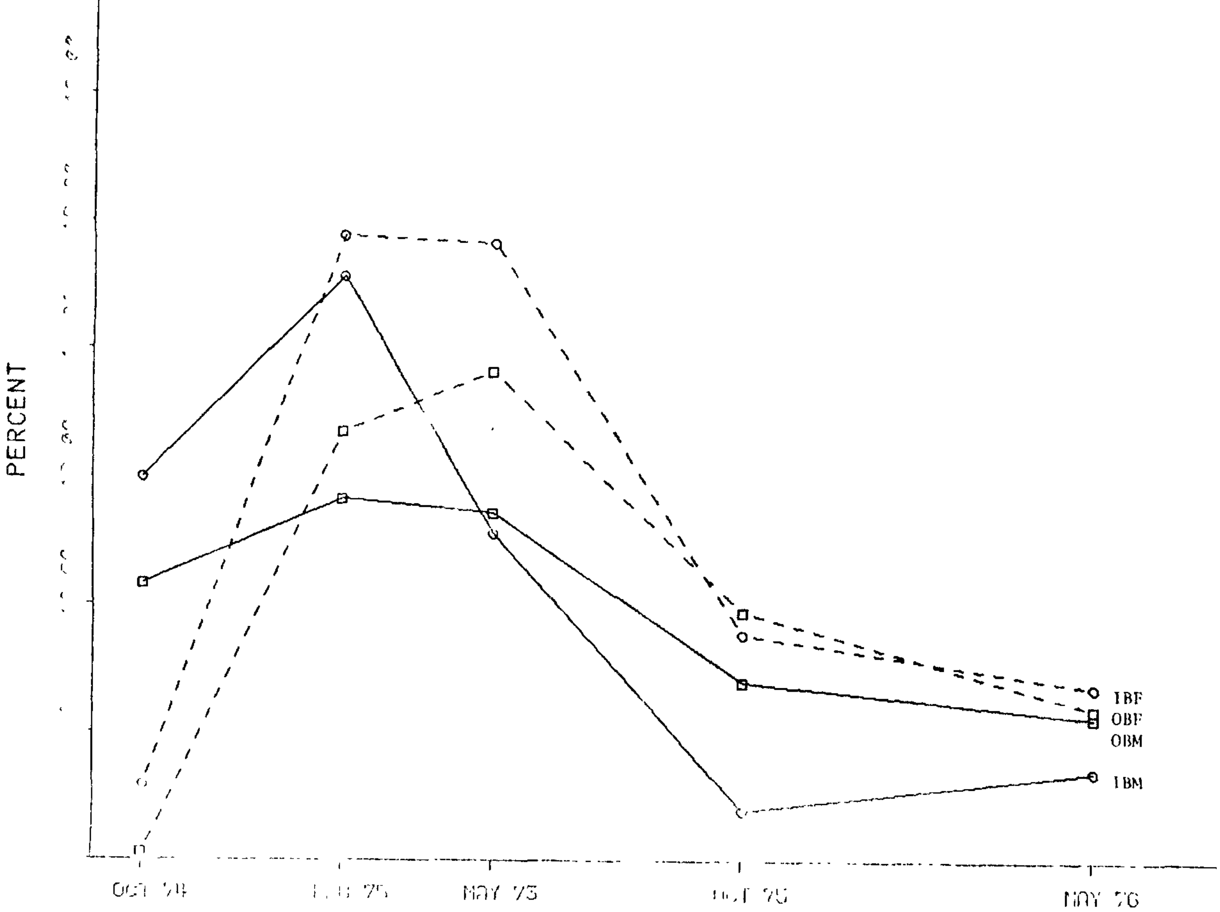
				OCT 74	FEB 75	MAY 75	OCT 75	MAY 76	
	GROUPS:		N	1	2	3	4	5	TOTAL
Means	IN MALE	1	16	1.125	1.562	2.375	.875	2.000	1.588
	IN FEMALE	2	17	2.588	3.765	3.588	1.824	2.118	2.776
	OUT MALE	3	18	1.111	1.722	1.778	.778	1.389	1.356
	OUT FEMALE	4	17	1.412	2.118	3.118	.412	2.000	1.812
	TOTAL		68	1.559	2.294	2.706	.971	1.868	1.879
Standard Deviations	IN MALE	1	16	1.147	1.209	1.544	1.544	2.503	1.711
	IN FEMALE	2	17	2.063	2.927	1.839	1.879	2.288	2.316
	OUT MALE	3	18	.963	1.179	1.166	.943	1.420	1.183
	OUT FEMALE	4	17	1.372	1.166	1.764	.712	1.732	1.637
	TOTAL		68	1.539	1.955	1.711	1.414	1.992	1.827

Figure 12. Mean Isogaps per 100 Cells - Rescan Group



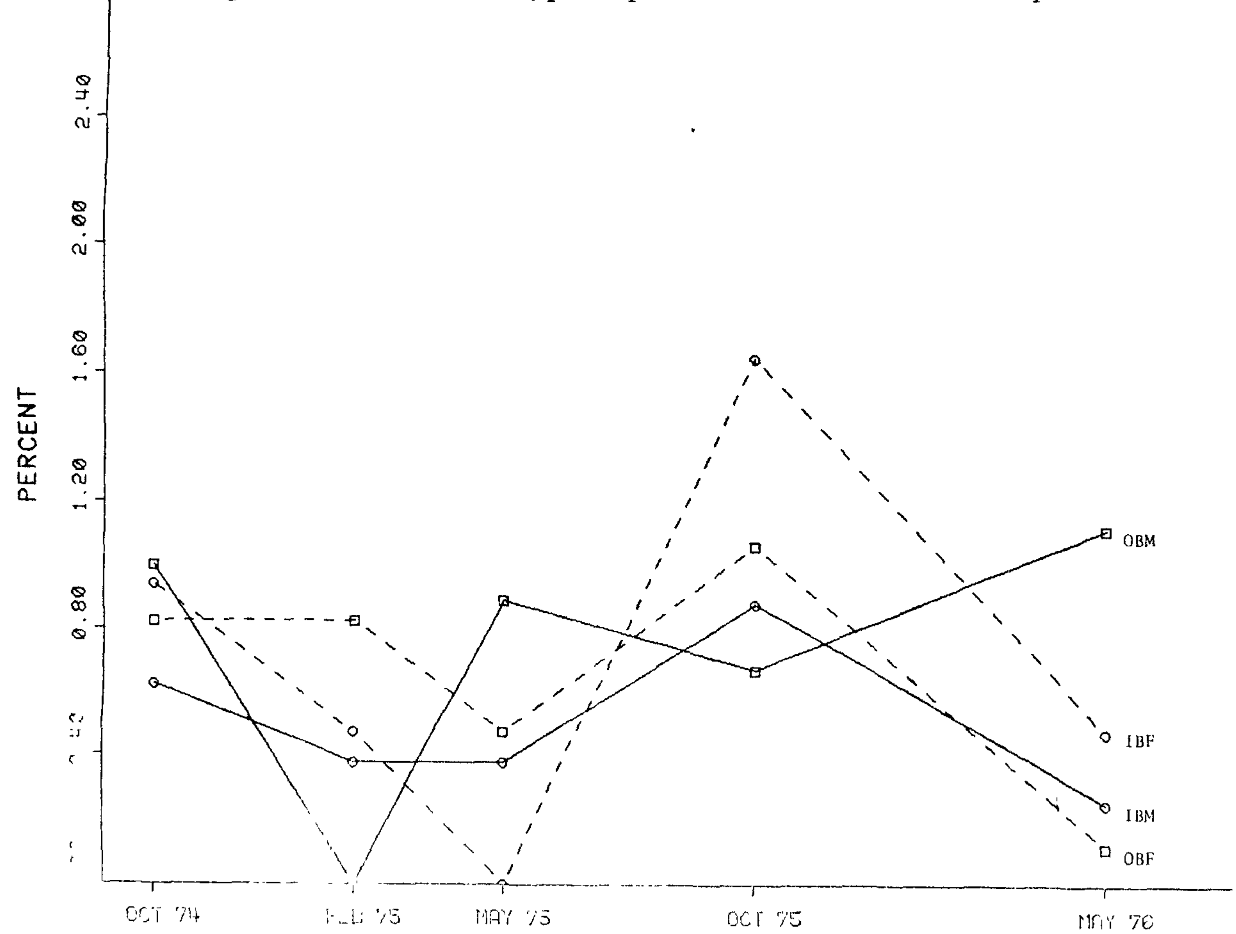
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.063	.125	.125	.063	.188	.112
	IN FEMALE	2	17	.235	.059	.235	.059	.118	.141
	OUT MALE	3	18	.111	.000	.111	.000	.222	.089
	OUT FEMALE	4	17	.000	.000	.176	.059	.059	.059
	TOTAL		68	.103	.044	.162	.044	.147	.100
Standard Deviations	IN MALE	1	16	.250	.342	.342	.250	.403	.318
	IN FEMALE	2	17	.437	.243	.437	.243	.332	.350
	OUT MALE	3	18	.323	.000	.323	.000	.428	.286
	OUT FEMALE	4	17	.000	.000	.393	.243	.243	.237
	TOTAL		68	.306	.207	.371	.207	.357	.300

Figure 13. Percent Hypodiploid Cells - Rescan Group



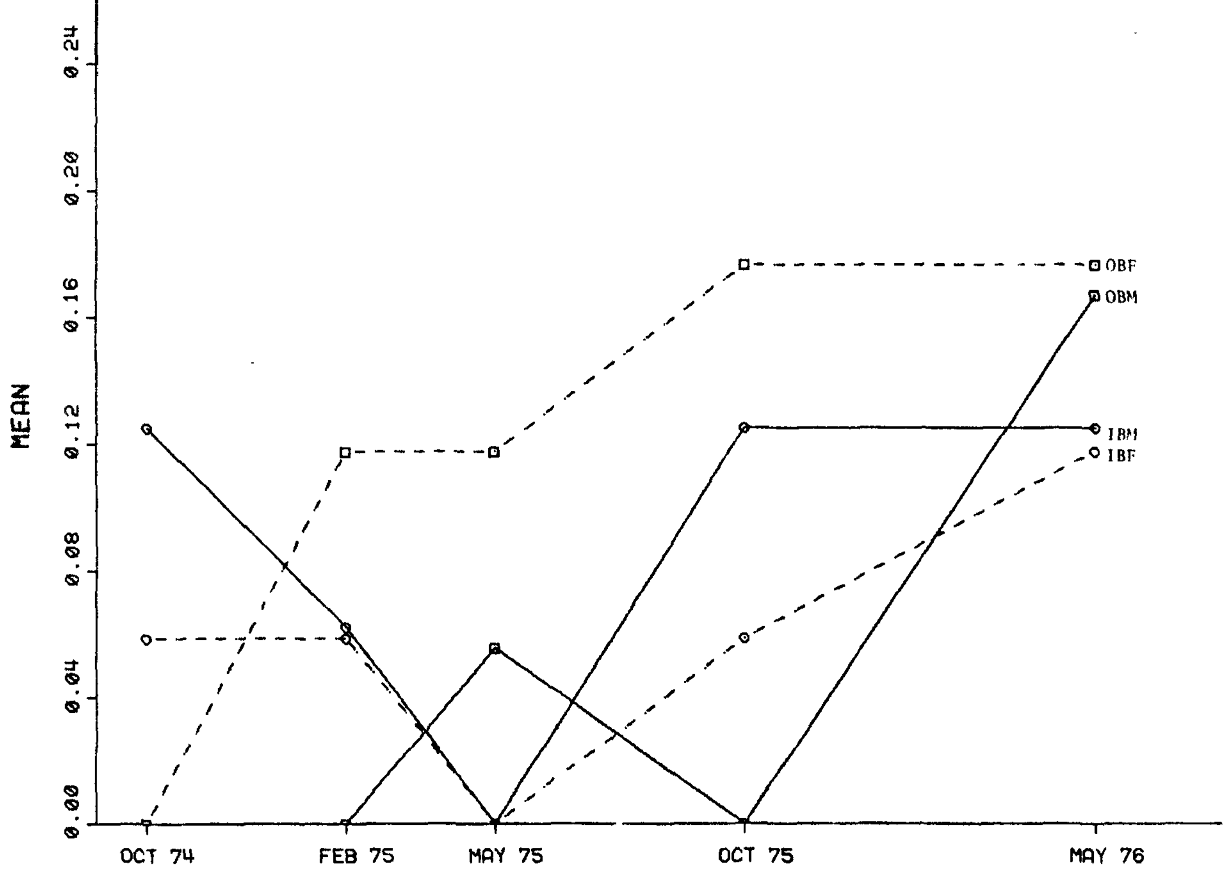
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	12.000	15.125	11.125	6.750	7.375	10.475
	IN FEMALE	2	17	7.176	15.765	15.647	9.529	[illegible]	11.365
	OUT MALE	3	18	10.333	11.667	11.444	8.778	8.222	10.089
	OUT FEMALE	4	17	6.118	12.706	13.647	9.882	8.353	10.141
	TOTAL		68	8.882	13.765	12.971	8.765	8.176	10.512
Standard Deviations	IN MALE	1	16	6.772	6.238	7.830	5.927	6.098	7.153
	IN FEMALE	2	17	11.114	5.333	6.010	7.954	8.404	8.653
	OUT MALE	3	18	4.563	[illegible]	7.602	5.663	5.694	6.288
	OUT FEMALE	4	17	4.091	5.698	7.754	5.633	4.703	6.232
	TOTAL		68	7.390	6.311	7.309	6.334	[illegible]	[illegible]

Figure 14. Percent Hyperdiploid Cells - Rescan Group



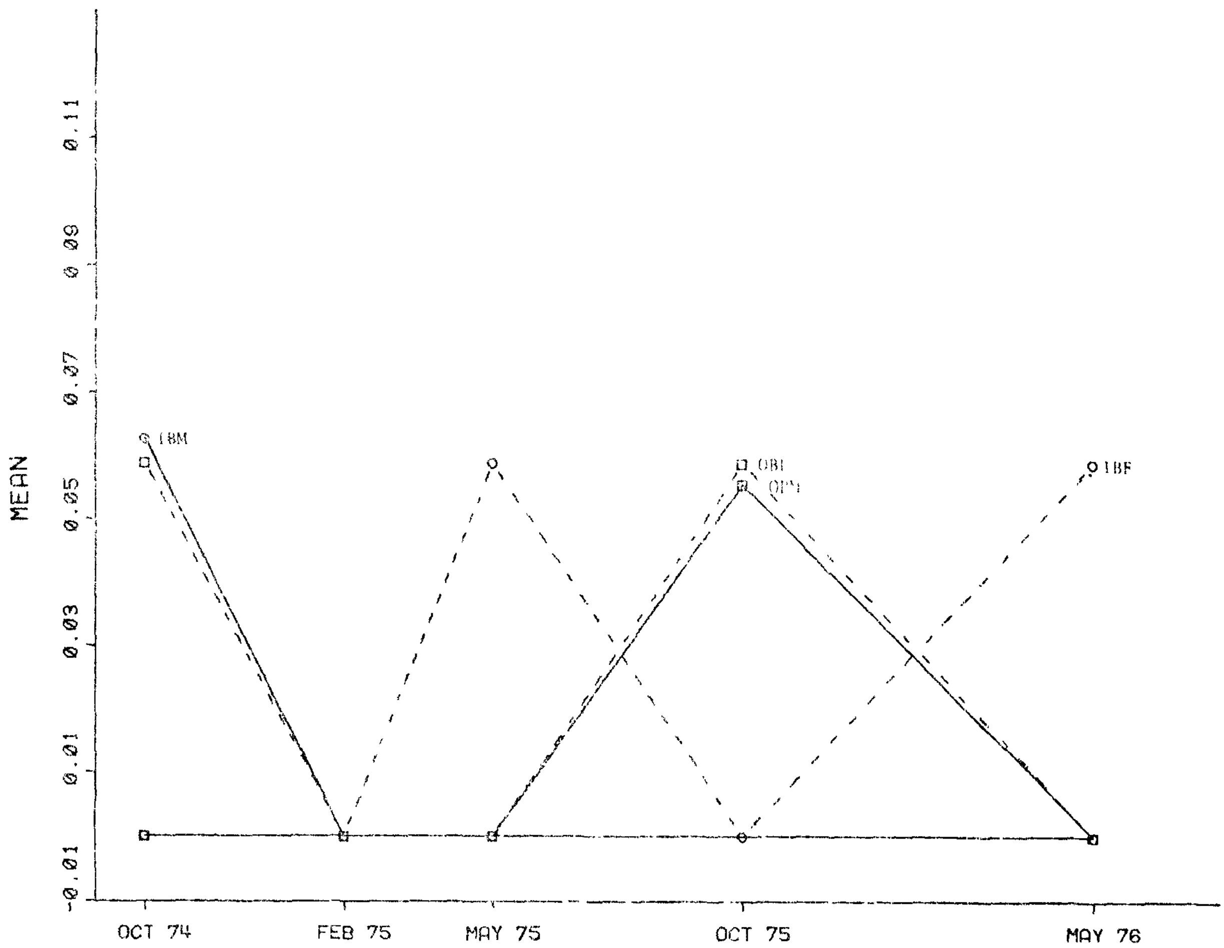
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.625	.375	.375	.875	.250	.500
	IN FEMALE	2	17	.941	.471	.000	1.647	.471	.706
	OUT MALE	3	18	1.000	.000	.889	.667	1.111	.733
	OUT FEMALE	4	17	.824	.824	.471	1.059	.118	.659
	TOTAL		68	.853	.412	.441	1.059	.500	.653
Standard Deviations	IN MALE	1	16	1.204	1.088	1.088	1.455	.683	1.125
	IN FEMALE	2	17	2.135	1.328	.000	3.823	.874	2.109
	OUT MALE	3	18	1.414	.000	2.298	1.630	2.676	1.859
	OUT FEMALE	4	17	1.237	2.128	1.328	2.135	.485	1.585
	TOTAL		68	1.519	1.363	1.460	2.430	1.521	1.713

Figure 15. Mean Stable Changes per 100 Cells - Rescan Group



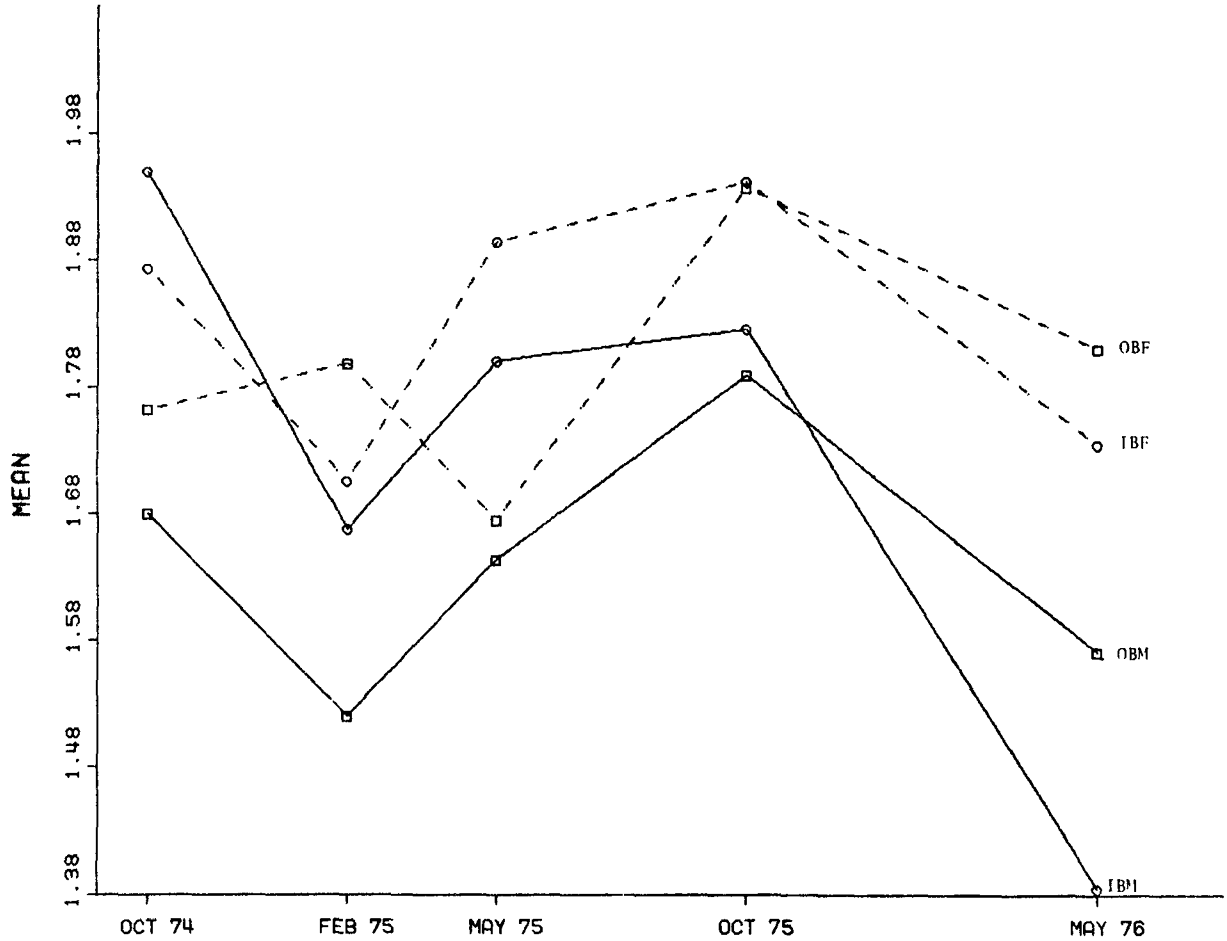
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.125	.063	.000	.125	.125	.088
	IN FEMALE	2	17	.059	.059	.000	.059	.118	.059
	OUT MALE	3	18	.000	.000	.056	.000	.167	.044
	OUT FEMALE	4	17	.000	.118	.118	.176	.176	.118
	TOTAL		68	.044	.059	.044	.088	.147	.076
Standard Deviations	IN MALE	1	16	.500	.250	.000	.342	.342	.326
	IN FEMALE	2	17	.243	.243	.000	.243	.332	.237
	OUT MALE	3	18	.000	.000	.236	.000	.383	.207
	OUT FEMALE	4	17	.000	.485	.332	.393	.393	.359
	TOTAL		68	.270	.293	.207	.286	.357	.287

Figure 16. Mean Endoreduplications per 100 Cells - Rescan Group



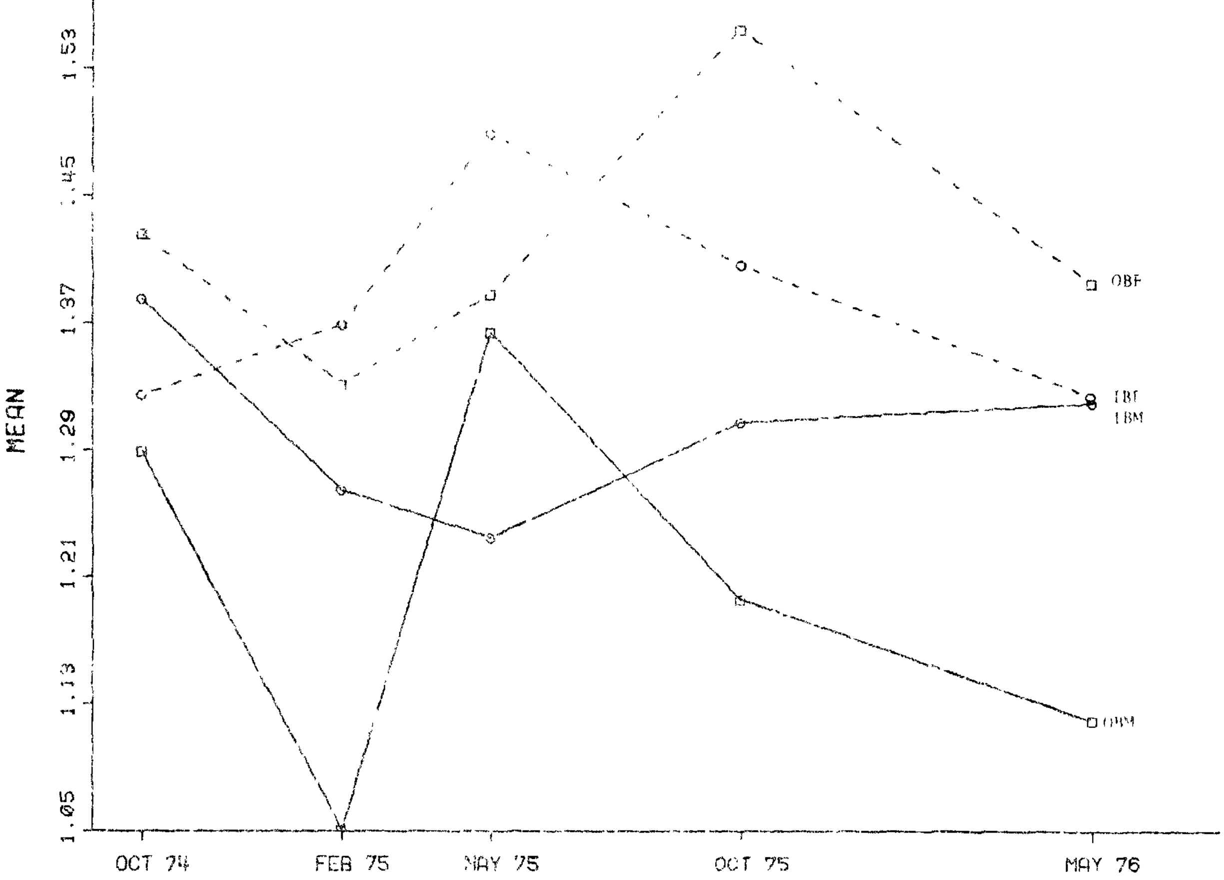
				OCT 74	FEB 75	MAY 75	UCT 75	MAY 76	
	GROUPS:		N	1	2	3	4	5	TOTAL
Means	IN MALE	1	16	.063	.000	.000	.000	.000	.012
	IN FEMALE	2	17	.000	.000	.059	.000	.059	.024
	OUT MALE	3	18	.000	.000	.000	.056	.000	.011
	OUT FEMALE	4	17	.059	.000	.000	.059	.000	.024
	TOTAL		68	.029	.000	.015	.029	.015	.018
Standard Deviations	IN MALE	1	16	.250	.000	.000	.000	.000	.112
	IN FEMALE	2	17	.000	.000	.243	.000	.243	.152
	OUT MALE	3	18	.000	.000	.000	.236	.000	.105
	OUT FEMALE	4	17	.243	.000	.000	.243	.000	.152
	TOTAL		68	.170	.000	.121	.170	.121	.132

Figure 17. Mean No. of D's Associated per Cell



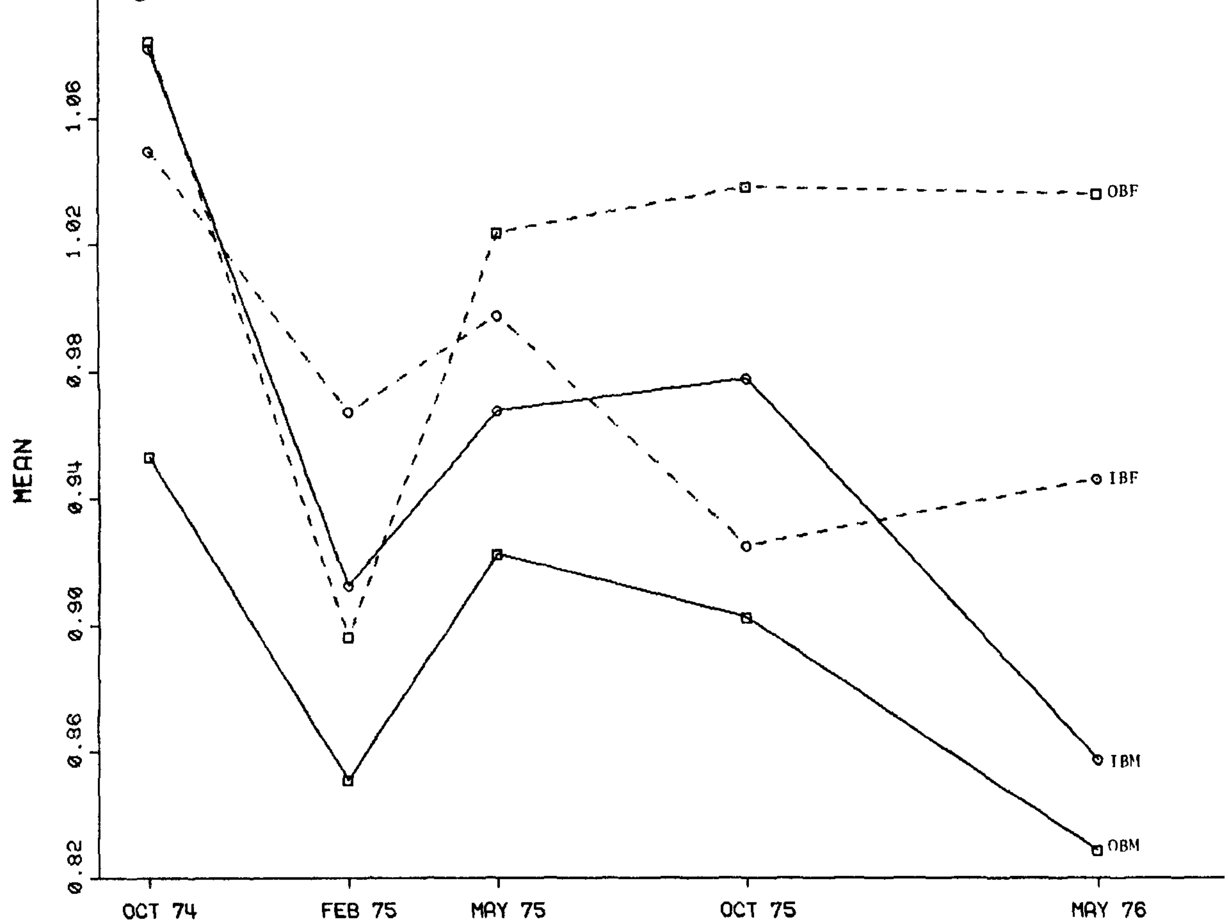
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	1.950	1.668	1.800	1.825	1.385	1.725
	IN FEMALE	2	17	1.873	1.706	1.894	1.941	1.734	1.830
	OUT MALE	3	18	1.680	1.520	1.644	1.789	1.571	1.641
	OUT FEMALE	4	17	1.762	1.798	1.675	1.936	1.809	1.796
	TOTAL		68	1.812	1.671	1.751	1.872	1.628	1.747
Standard Deviations	IN MALE	1	16	.429	.501	.487	.413	.445	.485
	IN FEMALE	2	17	.590	.620	.558	.499	.754	.603
	OUT MALE	3	18	.447	.483	.461	.611	.642	.531
	OUT FEMALE	4	17	.437	.547	.502	.412	.495	.477
	TOTAL		68	.481	.538	.502	.487	.608	.530

Figure 18. Mean No. of [illegible] Associated per Cell



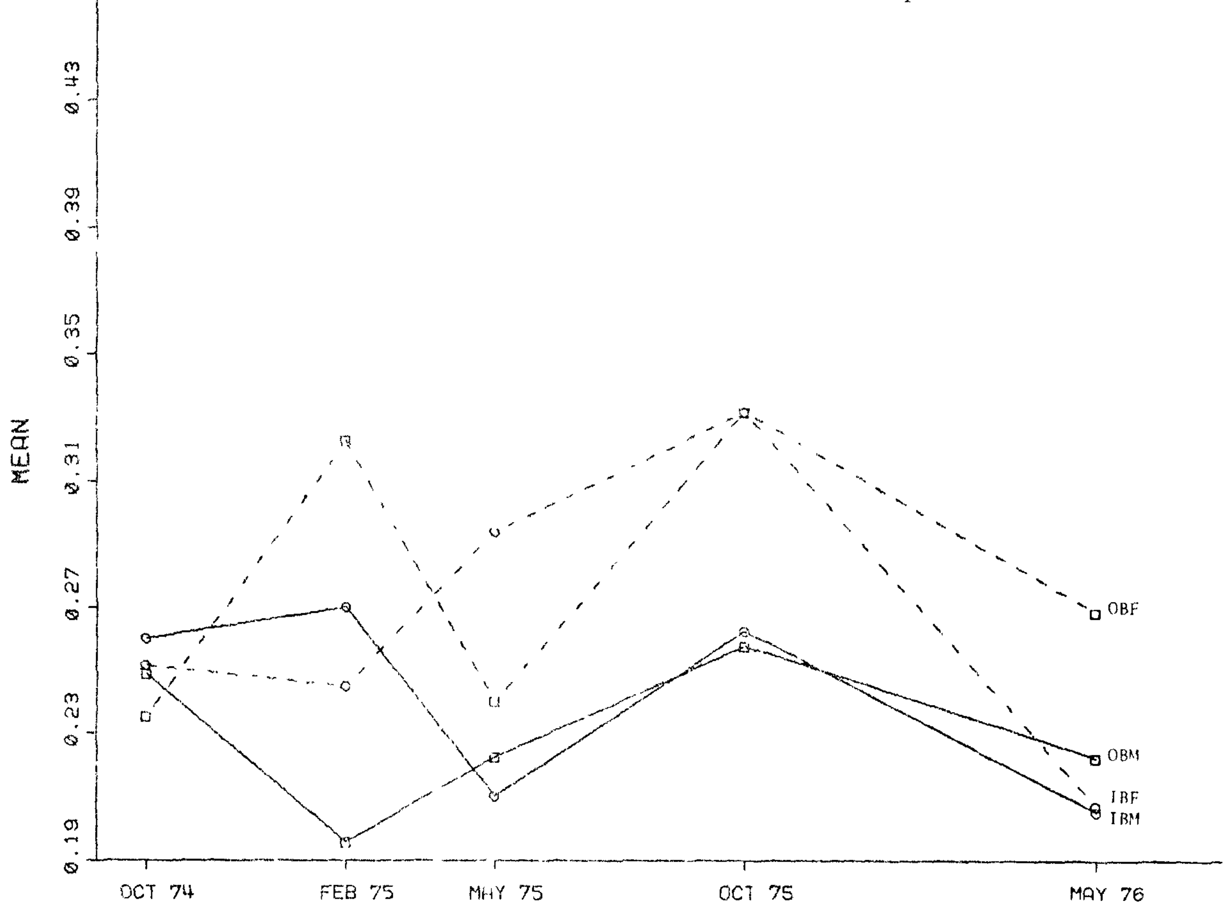
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	[illegible]	[illegible]	1.285	1.307	1.320	1.303
	IN FEMALE	2	17	[illegible]	[illegible]	1.480	1.467	1.325	1.383
	OUT MALE	3	18	[illegible]	[illegible]	1.164	1.196	1.120	1.204
	OUT FEMALE	4	17	1.425	[illegible]	1.339	1.555	1.395	1.419
	TOTAL		68	[illegible]	1.251	1.371	1.365	1.267	1.326
Standard Deviations	IN MALE	1	[illegible]	[illegible]	[illegible]	.459	.339	.557	.429
	IN FEMALE	2	[illegible]	.487	[illegible]	.363	.401	.376	.408
	OUT MALE	3	[illegible]	[illegible]	.384	[illegible]	.345	.385	.414
	OUT FEMALE	4	[illegible]	.501	.500	.508	.362	.482	.444
	TOTAL		[illegible]	.465	.452	.353	.379	.454	.430

Figure 19. Mean No. of 2 Chromosome Associations per Cell



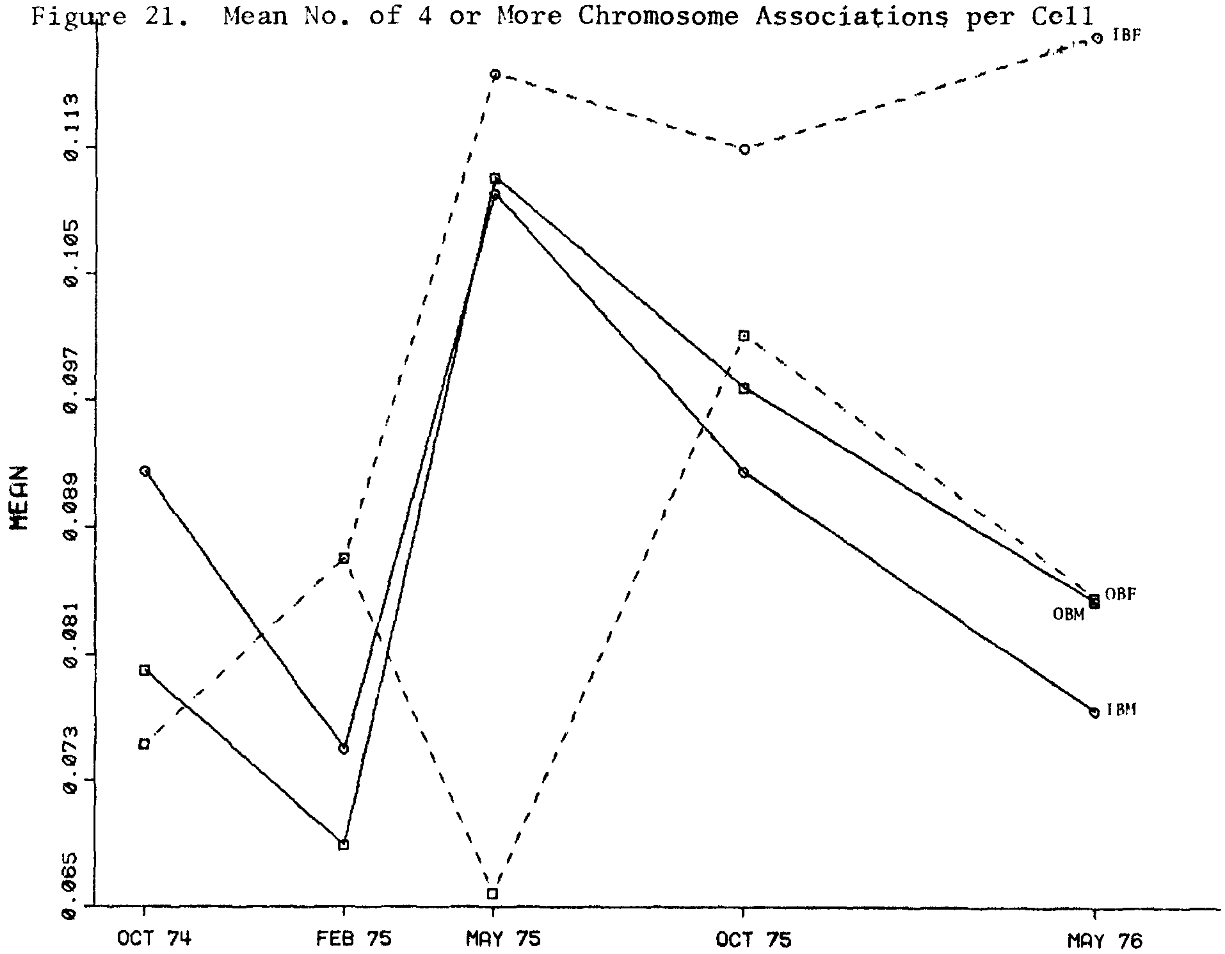
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	1.062	.913	.967	.977	.857	.959
	IN FEMALE	2	17	1.049	.967	.998	.925	.946	.977
	OUT MALE	3	18	.953	.851	.922	.902	.829	.892
	OUT FEMALE	4	17	1.085	.896	1.024	1.038	1.035	1.016
	TOTAL		68	1.041	.906	.977	.959	.916	.960
Standard Deviations	IN MALE	1	16	.165	.190	.269	.206	.274	.232
	IN FEMALE	2	17	.258	.249	.179	.173	.278	.230
	OUT MALE	3	18	.197	.225	.244	.171	.172	.205
	OUT FEMALE	4	17	.229	.305	.195	.175	.246	.237
	TOTAL		68	.218	.245	.222	.185	.253	.230

Figure 20. Mean No. of 3 Chromosome Associations per Cell



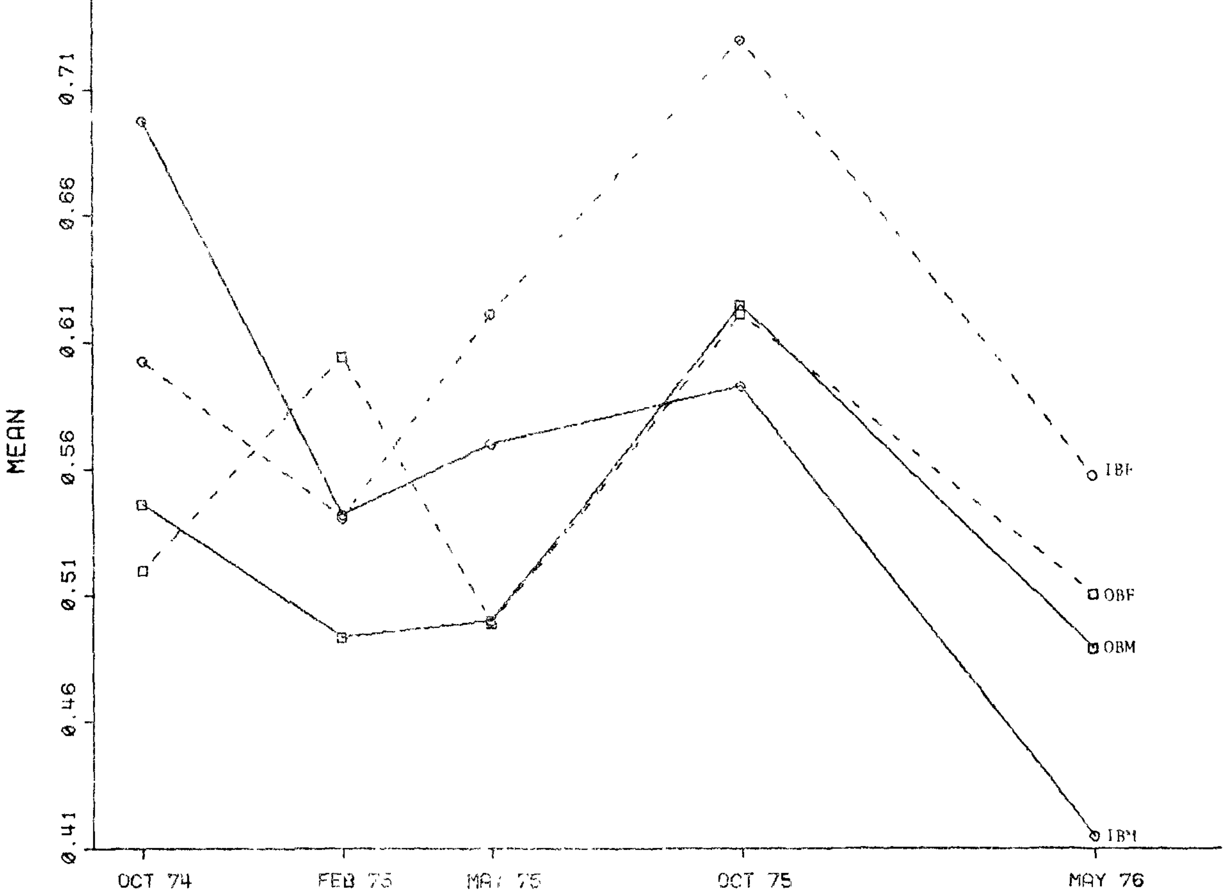
				OCT 74	FEB 75	MAY 75	OCT 75	MAY 76	
	GROUPS:		[illegible]	1	2	3	4	5	TOTAL
Means	IN MALE	1	16	[illegible]	.270	.210	.262	.205	.242
	IN FEMALE	2	17	.250	.245	.294	.332	.207	.266
	OUT MALE	3	[illegible]	.249	.196	.222	.258	.222	.229
	OUT FEMALE	4	17	.235	.302	.340	.332	.268	.280
	TOTAL		63	.249	.257	.242	.296	.226	.254
Standard Deviations	IN MALE	1	13	[illegible]	.125	.100	.119	.138	.118
	IN FEMALE	2	17	.124	.125	.131	.139	.116	.132
	OUT MALE	3	13	[illegible]	.145	.105	.126	.130	.127
	OUT FEMALE	4	17	.103	.175	.118	.145	.117	.129
	TOTAL		63	.115	.138	116	.135	.125	.128

Figure 21. Mean No. of 4 or More Chromosome Associations per Cell



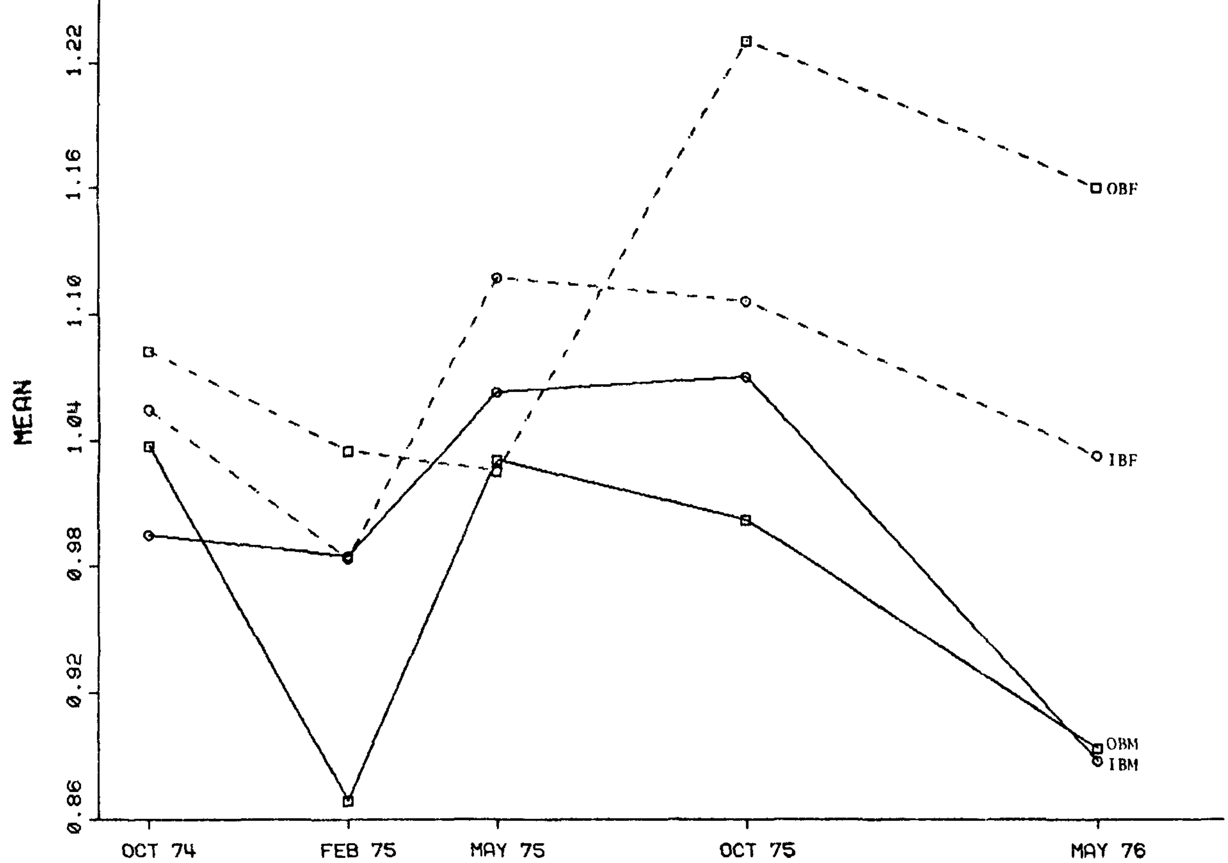
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.093	.075	.110	.093	.078	.090
	IN FEMALE	2	17	.075	.087	.118	.113	.120	.103
	OUT MALE	3	18	.080	.069	.111	.098	.084	.088
	OUT FEMALE	4	17	.075	.087	.066	.101	.085	.083
	TOTAL		68	.081	.079	.101	.101	.092	.091
Standard Deviations	IN MALE	1	16	.081	.060	.086	.075	.093	.079
	IN FEMALE	2	17	.065	.080	.061	.092	.103	.082
	OUT MALE	3	18	.058	.063	.079	.075	.092	.074
	OUT FEMALE	4	17	.060	.076	.058	.063	.076	.067
	TOTAL		68	.065	.069	.073	.076	.091	.076

Figure 22. Mean No. of D-D Associations per Cell



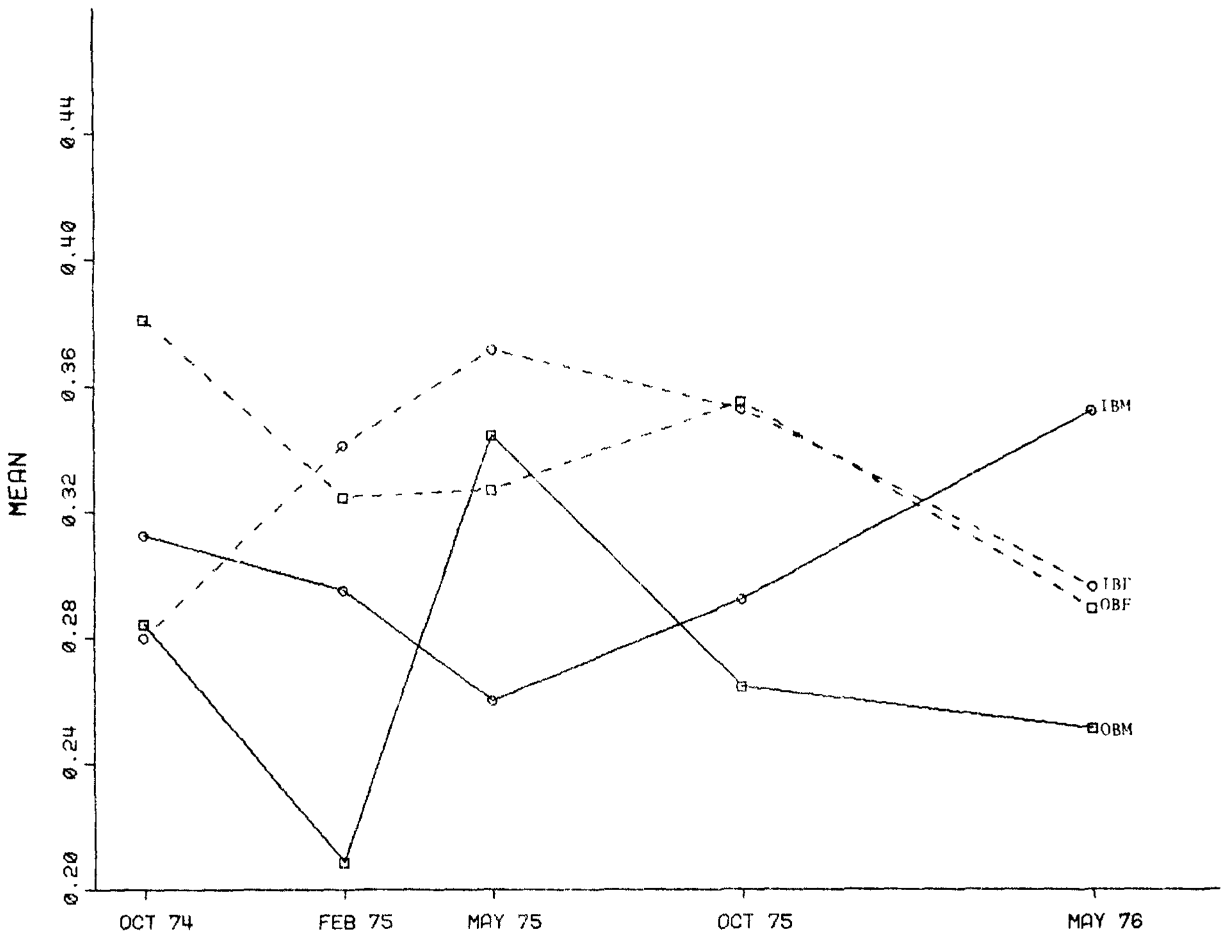
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.697	.543	.570	.592	.415	.563
	IN FEMALE	2	[illegible]	[illegible]	[illegible]	.621	.729	.558	.610
	OUT MALE	3	13	[illegible]	[illegible]	.500	.624	.489	.531
	OUT FEMALE	4		.518	[illegible]	.495	.621	.511	.551
	TOTAL		[illegible]	.569	545	.546	.642	.494	.563
Standard Deviations	IN MALE	1	16	[illegible]	[illegible]	.217	.264	.241	.263
	IN FEMALE	2	[illegible]	[illegible]	[illegible]	.350	.351	[illegible]	.347
	OUT MALE	3	[illegible]	[illegible]	[illegible]	.264	.379	[illegible]	.301
	OUT FEMALE	4	7	[illegible]	[illegible]	.254	.301	.303	.271
	TOTAL		[illegible]	[illegible]	.253	.275	.325	.314	.298

Figure 23. Mean No. of D-G Associations per Cell



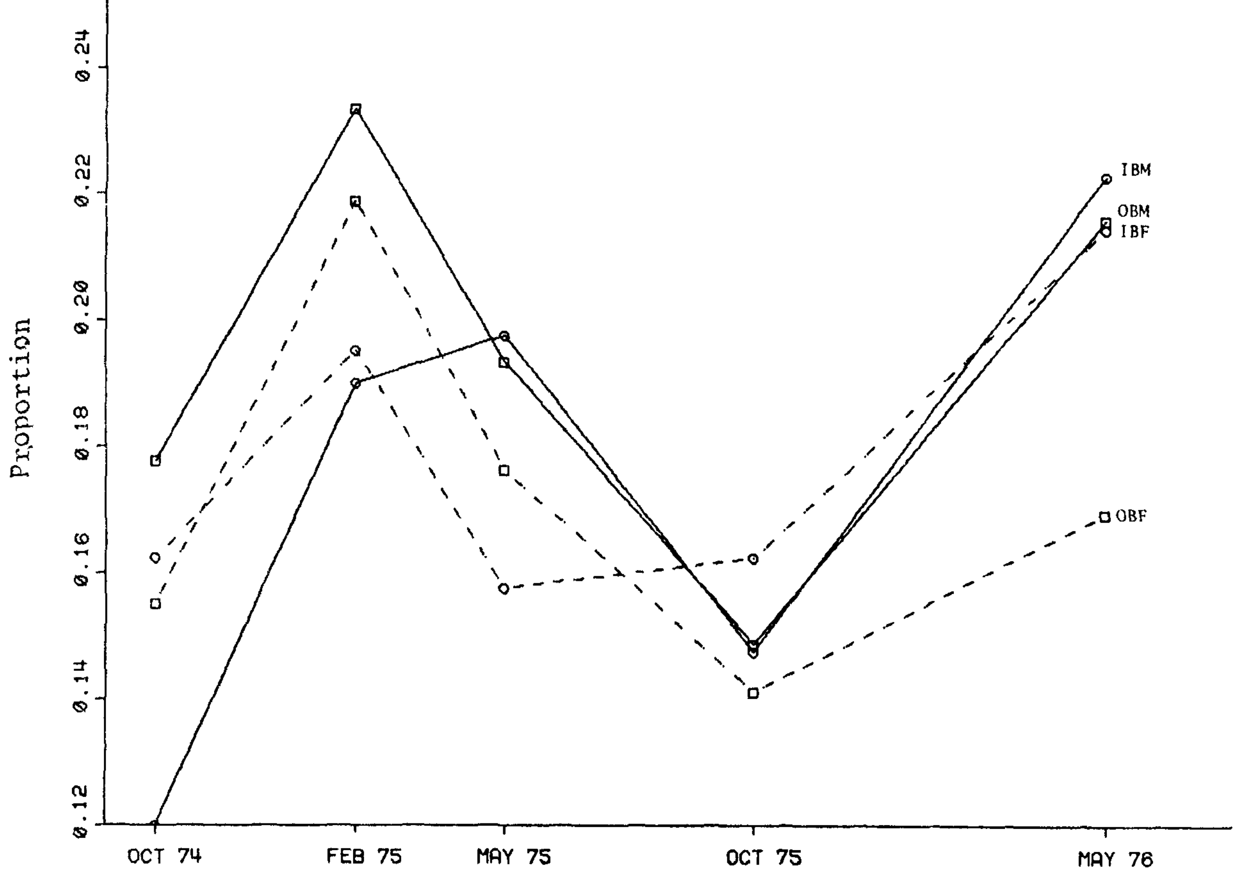
	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.995	.985	1.062	1.070	.888	1.000
	IN FEMALE	2	17	1.054	.984	1.118	1.106	1.033	1.059
	OUT MALE	3	18	1.038	.869	1.031	1.002	.893	.967
	OUT FEMALE	4	17	1.082	1.035	1.026	1.231	1.160	1.107
	TOTAL		68	1.043	.966	1.059	1.101	.994	1.033
Standard Deviations	IN MALE	1	16	.380	.352	.426	.239	.326	.348
	IN FEMALE	2	17	.333	.359	.277	.279	.428	.335
	OUT MALE	3	18	.383	.288	.235	.324	.313	.313
	OUT FEMALE	4	17	.445	.350	.292	.285	.275	.336
	TOTAL		68	.380	.336	.308	.290	.351	.336

Figure 24. Mean No. of G-G Associations per Cell



	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.313	.295	.260	.293	.353	.303
	IN FEMALE	2	17	.280	.341	.372	.353	.296	.328
	OUT MALE	3	18	.284	.209	.344	.264	.251	.271
	OUT FEMALE	4	17	.381	.325	.327	.355	.289	.336
	TOTAL		68	.314	.291	.327	.316	.296	.309
Standard Deviations	IN MALE	1	16	.156	.197	.172	.180	.229	.186
	IN FEMALE	2	17	.201	.227	.164	.192	.118	.183
	OUT MALE	3	18	.207	.211	.226	.158	.186	.199
	OUT FEMALE	4	17	.255	.163	.159	.178	.187	.193
	TOTAL		68	.208	.237	.183	.178	.183	.192

Figure 25. Proportion of Cells with No Associations



	GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
Means	IN MALE	1	16	.120	.190	.197	.148	.222	.176
	IN FEMALE	2	17	.162	.195	.158	.162	.214	.178
	OUT MALE	3	18	.178	.233	.193	.149	.216	.194
	OUT FEMALE	4	17	.155	.219	.176	.141	.169	.172
	TOTAL		68	.155	.210	.181	.150	.205	.180
Standard Deviations	IN MALE	1	16	.092	.127	.111	.082	.137	.115
	IN FEMALE	2	17	.132	.103	.092	.083	.130	.109
	OUT MALE	3	18	.088	.124	.108	.109	.141	.117
	OUT FEMALE	4	17	.109	.123	.099	.079	.091	.102
	TOTAL		68	.106	.118	.102	.088	.126	.111

Figure 26a. Monthly Averages of 1-Hour Readings for Selected Pollutants

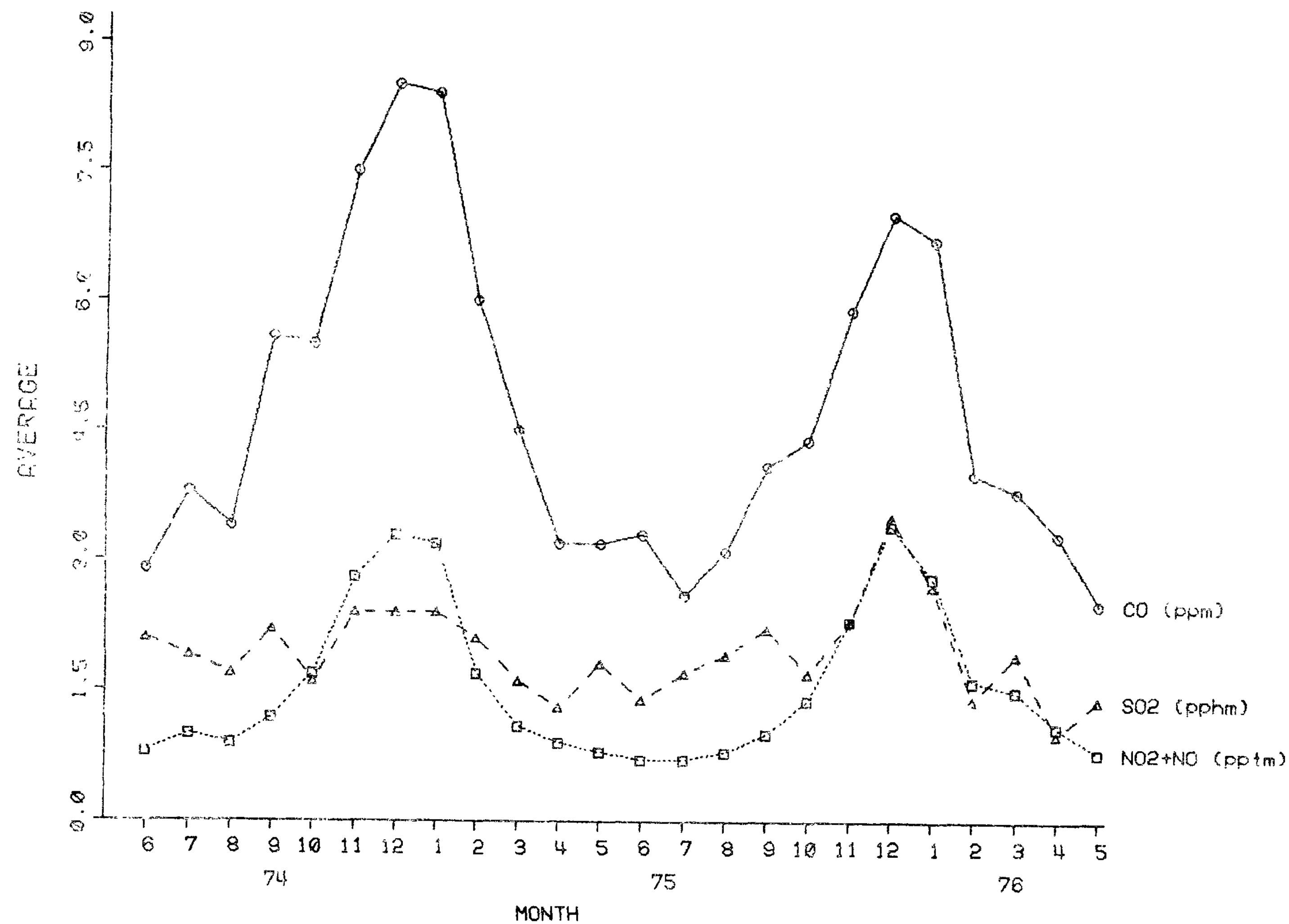
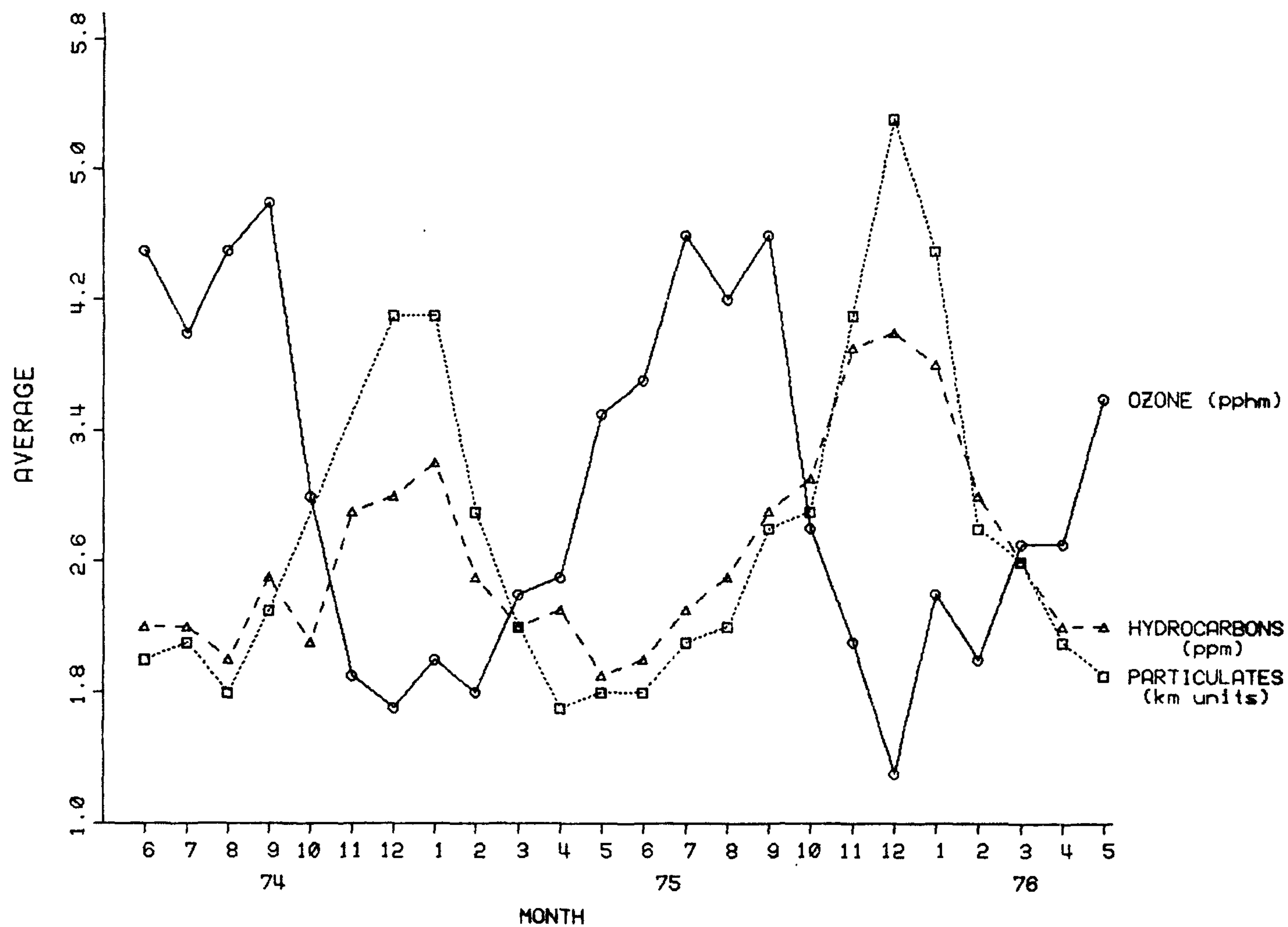


Figure 26b. Monthly Averages of 1-Hour Readings for Selected Pollutants



DISCUSSION

This study of students who have been exposed to the photochemical air pollutants in the Los Angeles Basin provides evidence that both in-basin males and females show statistically significantly higher levels of cytogenetic aberrations than the out-of-basin males and females. The magnitude of cytogenetic differences between in- and out-of-basin students was greater for males than for females. There was also a statistically significant association between aberrations and sampling periods.

The rescan group analyses revealed that there was a statistically significant difference between the original scans and rescans. These differences can be attributed to technical personnel and their continued improvement of cytogenetic assessment, as well as different slides selected at each scanning period by different technicians. The differences, however, were distributed equally among the four study groups; so all intergroup comparisons are still valid. With regard to the major variables of interest, the original scan and rescan analyses both show similar differences between in- and out-of-basin subjects.

The major difference between analyses is in the magnitude of the time trends; a more accurate assessment of time trends can be observed if only the rescan data are used. Although fewer subjects were analyzed and the data are more variable, the data are likely to be a truer representation of real time trends since the scoring procedures were more consistent at later time periods when the data were rescanned.

The interpretation of the results is complicated by the complex nature of the pollutants and the impossibility of incriminating specific pollutants in a study such as this. For instance, it is not known whether students are capable of developing a tolerance to oxidants (ozone), as has been reported for animals [17]. If such a development of tolerance occurs in the in-basin group, this could account for the greater difference between in- and out-of-basin groups in cytogenetic aberrations for the initial sampling period (October 74), and a lesser degree of damage between in-basin and out-of-basin groups after several months of exposure. However, there is no evidence to support such a hypothesis.

Our observation of cytogenetic damage correlated with the concentrations of pollutants with a difference in time of 4 to 8 months is one of the most puzzling and, hence, most interesting findings which is derived from this study. It is difficult to separate the effects of each pollutant, as well as consider the synergistic effects of several due to their reactions in the atmosphere. It is significant to point out that carbon monoxide and, to some extent, nitrogen dioxide/nitric oxide gave significant positive correlations and ozone showed significant negative correlations with abnormality variables, assuming a four-month lag between exposure and cell abnormalities. Also, if we assume an eight-month lag for ozone exposure, there is a positive correlation for abnormal cells and gaps. These results cannot be viewed as indicative of a cause and effect relationship, but are presented only for the purpose of generating hypotheses.

Ottesen [18], using P^{32} as a DNA label, observed that lymphocytes can be divided in two groups on the basis of life span, one with a short survival time of up to 4 days and the other with a longer survival time of 100 to 200 days. He further reported that in man, about 11% to 22% of the lymphocytes were short-lived, and 78% to 89% were long-lived. This survival time for the majority of lymphocytes corresponds to the lag time of 4 months (120 days) by which lymphocyte changes followed similar changes in pollutant levels in the Los Angeles Basin.

It should be kept in mind that cellular damage resulting in chromatid breaks, chromatid gaps (at least those that represent break points), and both free and terminal fragments probably represent events that occurred in the cell cycle immediately preceding the metaphase that was observed. Bender and Prescott [19] reported that when peripheral lymphocytes in culture were harvested after 3 to 4 days, a great majority of mitosis was still in their first division *in vitro*. A similar result was obtained by MacKinney, et al. [20]. These reports suggest that most of the cells with chromosomal aberrations were probably damaged *in vivo* and not associated with culture techniques. There are many factors which influence the sensitivity of the lymphocyte life span and divisional cycle. If ozone is mutagenic, then its effect is unlikely to be limited to lymphocytes, but may also encompass other tissues and organs including the gonads, with the resultant danger in the form of "genetic deaths". Damage to the germ cells may consist of mutations that could lead to an increased rate of genetic disorders in subsequent generations. It is the opinion of some geneticists that the induction of significant numbers of chromosomal aberrations is a sign of potential genetic danger. As a rule, chemical mutagens known to produce chromosome breakage also produce point mutations and may become evident only after many generations.

It has been known and widely accepted that the percentage of aneuploid (hypo- hyper-diploid) cells varies a great deal with the age of individuals and can also be influenced by sex [21]. The fact that we did not observe any differences in aneuploid cells within the between groups (males and females) can probably be explained by the selection of perfectly spread metaphases by our scanners and also because the ages of our study group were relatively uniform. However, for the purpose of this paper, it is enough to state that a time trend is correlated with the amount of aneuploid cells observed. It has been reported by Verschaeve, et al. [22], that occupationally exposed subjects to mercury had statistically significant increased percentage of aneuploid cells as compared to nonexposed subjects and, therefore, a measure of cellular changes caused by exposure.

A comparison of the chromosomal aberrations and the frequency of gaps as related to the time of sampling of students appears to be related.

However, gap counting in the evaluation of chromosomal aberrations may be considered problematical. Nevertheless, some investigators show that gaps represent a type of abnormality very characteristic of chemical mutagens.

Satellite association analysis revealed no consistent differences between in- and out-of-basin students or among time periods and does not appear to be a significant parameter to measure as an indicator of cellular response to environmental contaminants. Overall, females showed more satellite association than males involving the "G" group chromosomes and in the number of two- and three-chromosome associations, e.g., G-G, G-G-G, D-G-G, D-G, and D-D-G associations.

In general, the differences in chromosomal aberrations observed between in- and out-of-basin students plus the relationship of chromosomal aberrations to pollutant levels and time of the year indicate that living in the Los Angeles Basin is related to higher than normal levels of chromosomal damage.

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APPENDIX A

Personal History Form

APPENDIX A

Personal History Form

____
Research Number

USC STUDENTS CHROMOSOME STUDY

PERSONAL HISTORY FORM

1. Name____
(last) (first) (middle)

2. Date of Birth__________________________
(day) (month) (year)

3. Sex Male ☐ Female ☐

4. Local Address (for Fall 1975):

____
Street

____
City/Town Zip

____
Telephone Number

Is this address a dormitory or student housing? Yes ☐ No ☐

Approximate distance from local address to campus __________
Miles

FOR OFFICE USE ONLY

5. Interviewer__________
Initials

6. Editor__________ Date Edited__________
Initials

____
Research Number

STATEMENT OF PERMISSION

I agree to participate voluntarily in this study of the effect of smog upon chromosomes. The purpose of the study has been explained to me. I have been informed that this study is being performed by the Utah Biomedical Test Laboratory of the University of Utah for the U.S. Environmental Protection Agency. I understand that the study is being performed with the full approval and cooperation of the Student Health and Counseling Services of the University of Southern California.

I understand that completion of this interview and a small venous blood sample will be asked of me. And I understand that I have the full right to refuse cooperation, including the right to refuse to answer any particular questions on this interview form.

I understand that no item of information collected directly from me will become part of my University record, that no items of information about me will be released to any individual for any purposes other than the scientific analysis of the data, that results will be reported as statistical summaries of data on groups of persons only, and that this data will be destroyed when its scientific usefulness is ended.

I understand that in the rare event that an item of information of medical importance to an individual is discovered, that item of information and an explanation of its significance will be given to the individual as soon as possible, but that no other authorities or persons will be informed.

____
Signature

____
Name (Printed)

Research Number

7. Have you ever had radiation therapy for a medical condition? YES ☐ NO ☐

IF YES: Describe the medical condition for which therapy was administered, and the type and dates of the therapy.

____

____

____

____

8. Have you ever been given radioactive substances for the diagnosis of a suspected medical condition? YES ☐ NO ☐

IF YES: Describe suspected medical conditions, test substances if known, and dates of diagnostic procedures.

____

____

____

____

9. Have you ever had x-rays, other than routine chest and dental x-rays? YES ☐ NO ☐

IF YES: Describe medical reason for x-ray(s), part of body x-rayed, and dates of x-rays.

____

____

____

____

____

Research Number

10. Have you ever undergone a diagnostic investigation of your thyroid gland? YES ☐ NO ☐

IF YES: Were radioactive substances used in diagnosis? And when did these diagnostic procedures take place?

____

____

____

____

11. Have you ever had medical treatment for tuberculosis? YES ☐ NO ☐

IF YES: Describe treatment, including drugs used if known. Give inclusive dates of treatment.

____

____

____

____

12. Have you ever taken drugs routinely for a period of more than one month as part of the medical treatment for a condition or as a preventive measure against the recurrence of a condition? (Include purely preventive drugs such as anti-malarials.) YES ☐ NO ☐

IF YES: Name drug(s) and give inclusive dates of treatment.

____

____

____

____

INSTRUCTIONS AND EXAMPLES

INSTRUCTIONS: The following questions need to be answered in such a way that we can analyse your responses for each of the three or four month periods between each blood drawing, as well as for two such periods previous to the first blood drawing.

Questions refering to habits, such as cigarette smoking, refer to the period immediately preceding a blood drawing if your habit changed. For example, if you stopped smoking between May and October you would check "NO" for that period.

Questions refering to occurrences, such as illnesses or the taking of medication, are to be answered "YES" if the illness occurred at any time during the period.

PLEASE READ THE FOLLOWING TWO EXAMPLES

IF YOU HAVE ANY QUESTIONS NOW, OR WHEN ANSWERING QUESTIONS, PLEASE ASK OUR TECHNICIAN

SAMPLE QUESTION: Do you, and did you, regularly smoke cigarettes? If "yes" in any period please record the average number smoked per day. (A pack = 20; if you did not smoke every day, record " 1.")

SAMPLE ANSWER: I took up smoking the summer after high school, smoking a pack a day. Last spring I started smoking two packs a day, but I stopped completely this summer to protect my health.

SAMPLE CORRECT ENTRIES:

Feb 74 – May 74	May 74 – Oct 74	Oct 74 (1st Blood) – Feb 75	Feb 75 (2nd Blood) – May 75	May 75 (3rd Blood) – Oct 75 (4th Blood)
[X] No	[ ] No	[ ] No	[ ] No	[X] No
[ ] Yes	[X] Yes	[ ] Yes	[ ] Yes	[ ] Yes
Number/day	20 Number/day	Number/day	40 Number/day	Number/day

SAMPLE QUESTION: During any of the periods listed, did you receive any vaccinations or re-vaccinations?

SAMPLE ANSWER: During a physical my last semester in high school my family doctor gave me smallpox and one other; that summer I scraped my leg and got a Tetanus shot. This summer I traveled in Central America and got Yellow Fever and Smallpox just before I went.

SAMPLE CORRECT ENTRIES:

Feb 74 – May 74	May 74 – Oct 74	Oct 74 (1st Blood) – Feb 75	Feb 75 (2nd Blood) – May 75	May 75 (3rd Blood) – Oct 75 (4th Blood)
Smallpox	Tetanus			Smallpox
? Don't remember				Yellow Fever

17. During any of the periods listed, did you have an illness that caused you to break out in a rash?

IF YES: What was the illness?

▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes
Illness ______	Illness ______	Illness ______	Illness ______	Illness ______

/ Feb 74 — / May 74 — / Oct 74 1st Blood — / Feb 75 2nd Blood — / May 75 3rd Blood — / Oct 75 4th Blood

18. During any of the periods listed, did you get Infectious Mononucleosis?

▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes
XXXXX	XXXXX	XXXXXX	XXXXX	XXXXX

/ Feb 74 — / May 74 — / Oct 74 1st Blood — / Feb 75 2nd Blood — / May 75 3rd Blood — / Oct 75 4th Blood

19. During any of the periods listed, did you suffer from Serum or Infectious Hepatitis (Jaundice)?

IF YES: Give type, Infectious or Serum:

▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes	▢ No ▢ Yes
Type ______	Type ______	Type ______	Type ______	Type ______

/ Feb 74 — / May 74 — / Oct 74 1st Blood — / Feb 75 2nd Blood — / May 75 3rd Blood — / Oct 75 4th Blood

Research Number ______

Research Number

20. During any of the periods listed, did you have any other illness which incapacitated you from carrying out your normal activities for more than one week?

IF YES: List illness:

Feb 74 – May 74	May 74 – Oct 74 (1st Blood)	Oct 74 – Feb 75 (2nd Blood)	Feb 75 – May 75 (3rd Blood)	May 75 – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Illness	Illness	Illness	Illness	Illness

21. During any of the periods listed, did you suffer from Hay Fever?

IF YES: List the drug you took to control your symptoms.

(NOTE: If you suffered from active asthma, also check "yes" for the relevant periods and write in "asthma" beside it. Also list the drugs you took.)

Feb 74 – May 74	May 74 – Oct 74 (1st Blood)	Oct 74 – Feb 75 (2nd Blood)	Feb 75 – May 75 (3rd Blood)	May 75 – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Drug(s)	Drug(s)	Drug(s)	Drug(s)	Drug(s)

22. FOR FEMALE STUDENTS ONLY: During any of the periods listed, were you taking birth control pills?

IF YES: List brand used:

Feb 74 – May 74	May 74 – Oct 74 (1st Blood)	Oct 74 – Feb 75 (2nd Blood)	Feb 75 – May 75 (3rd Blood)	May 75 – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
Brand	Brand	Brand	Brand	Brand

Research Number

23. During any of the periods listed, did you take any other drugs, prescribed or non-prescribed? For example, aspirin, penicillin, etc.

IF YES: List drug(s) and reason:

Feb 74	May 74	Oct 74 1st Blood	Feb 75 2nd Blood	May 75 3rd Blood	Oct 75 4th Blood

24. During any of the periods listed, did you receive any vaccinations or re-vaccinations? (Commonly given as part of a routine physical exam, before foreign travel, or following accidental cuts or abrasions.)

IF YES: List vaccines received: (Common are Smallpox, Tetanus, DPT (Diphtheria-Whooping Cough-Typhoid), and Polio; Yellow Fever, Cholera, and others may be given to foreign travelers.)

Feb 74	May 74	Oct 74 1st Blood	Feb 75 2nd Blood	May 75 3rd Blood	Oct 75 4th Blood

25. During any of the periods listed below, have you been employed full or part time in any occupation involving the manufacture, processing, or handling of chemicals (for example, rubber, explosives, or insecticides)?

IF YES: List type of business, chemicals exposed to if known, and approximate exposure time in hours per week.

Feb 74	May 74	Oct 74 1st Blood	Feb 75 2nd Blood	May 75 3rd Blood	Oct 75 4th Blood

Research Number

26. Do you, and did you, regularly smoke cigarettes? If "yes" in any period please record the average number smoked per day. (A pack = 20; if you did not smoke every day, record <1.)

	Feb 74 – May 74	May 74 – Oct 74	Oct 74 (1st Blood) – Feb 75	Feb 75 (2nd Blood) – May 75	May 75 (3rd Blood) – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
	Number/day	Number/day	Number/day	Number/day	Number/day

27. Do you, and did you, regularly smoke a pipe and/or cigars? If "yes" in any period please record "pipe," "cigars," or "pipe & cigars."

	Feb 74 – May 74	May 74 – Oct 74	Oct 74 (1st Blood) – Feb 75	Feb 75 (2nd Blood) – May 75	May 75 (3rd Blood) – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
	Pipe? Cigars?	Pipe? Cigars?	Pipe? Cigars?	Pipe? Cigars?	Pipe? Cigars?

28. Do you, and did you, smoke marijuana once or more per week for most weeks in any period?

	Feb 74 – May 74	May 74 – Oct 74	Oct 74 (1st Blood) – Feb 75	Feb 75 (2nd Blood) – May 75	May 75 (3rd Blood) – Oct 75 (4th Blood)
☐ No	☐ No	☐ No	☐ No	☐ No	☐ No
☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes	☐ Yes
	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX

Research Number

29. Because we are concerned about chemicals to which you might have been exposed, we would like you to list any full or part-time jobs you have had at any time in the past which might have involved such exposures.

Do not list office jobs, domestic service, or service jobs such as waitress, sales clerk, delivery boy, etc.

DO list any job in agriculture, manufacturing, industry, or service jobs at places like gasoline filling stations, dry cleaners, etc., where you might have been exposed to chemicals.

IF IN DOUBT, LIST JOB AND GIVE DETAILS

Job Duties; Chemicals	Type of Business; Name and Location of Employer	Dates (Month and Year); Hours per Week

Continue on Rear if Necessary

30. List the places in which you spent more than two weeks during this summer vacation just past. (It helps us if you can possibly give the zip code!)

Town, City, or Suburb and City	State	Zip Code

IF MORE THAN ONE PLACE, INDICATE NUMBER OF WEEKS IN EACH

____
Research Number

31. Please give your local address(es) during the 1974-1975 school year (September 1974 through May 1975).

a) From ______________ to ______________
Month Month

____
Number Street

____
City/Town Zip

Is this address a dormitory or student housing? Yes No

Approximate distance from local address to campus______________
Miles

b) From______________ to ______________
Month Month

____
Number Street

____
City/Town Zip

Is this address a dormitory or student housing? Yes No

Approximate distance from local address to campus______________
Miles

32. List the places in which you spent more than two weeks during the summer vacation of 1974 (between high school and college).

Town, City, or Suburb and City	State	Zip Code
____________________	__________	__________
____________________	__________	__________
____________________	__________	__________
____________________	__________	__________

IF MORE THAN ONE PLACE, INDICATE NUMBER OF WEEKS IN EACH

Research Number

33. Beginning with your permanent address at the time you entered USC (fall 1974), please list each place you have lived for six months or more during your lifetime. Work backwards in time. It is not necessary to give street addresses. Please name major city if you resided in a suburb (it is much easier for us to code "Ladue, St. Louis, Missouri" than "Ladue, Missouri" for example).

City, or Suburb and City	County	State	Dates		Check One			
			From	To	Rural Area: Farm	Rural Area: Nonfarm	Urban Area: City	Urban Area: Suburb

34. How would you describe your ethnic background:

Black/Afro-American	▢	Mexican/Puerto Rican/ Other Latin American	▢
White/Caucasian American	▢	Oriental American	▢
Other American	▢	Non-Citizen	▢

IF NON-CITIZEN:

____
Country of Origin

____
Ethnic Group of Origin if relevant

WE THANK YOU FOR YOUR TIME AND COOPERATION!

APPENDIX B

Home Addresses by Chromosome Study Groups

APPENDIX B

TABLE B-1. HOME ADDRESSES OF OUT-OF-BASIN FEMALES

Research No.	Address	Length of Time at Address
208	Fremont, Ca.	11 yrs.
210	Berkeley, Ca.	14 yrs.
212	Paramus, NJ.	13 yrs.
214	San Francisco, Ca.	17 yrs.
222	Oxnard, Ca.	8 yrs.
228	Fresno, Ca.	14 yrs.
230	Clovis, Ca.	5 yrs.
234	Far Rockaway, NY.	14 yrs.
236	Elm Grove, Wi.	18 yrs.
240	Towson, Md.	8 yrs.
244	Colorado Springs, Co.	9 yrs.
246	Seattle, Wa.	3 mos.
248	Strathmore, Ca.	11 yrs.
249	El Centro, Ca.	18 yrs.
258	National City, Ca.	14 yrs.
266	San Carlos, Ca.	6 yrs.
286	Cincinnati, Oh.	13 yrs.
288	Oceanside, Ca.	3 yrs.
292	Honolulu, Hi.	16 yrs.
298	Ventura, Ca.	18 yrs.
300	Kenilworth, Ill.	19 yrs.
304	San Diego, Ca.	2 yrs.
310	Tampa, Fl.	8 yrs.
312	Ft. Benning, Ga.	12 yrs.
314	Hibbing, Mn.	3 yrs.
318	Thousand Oaks, Ca.	12 yrs.
320	Los Altos Hills, Ca.	5 yrs.
322	Sacramento, Ca.	1 yr.
326	Belmont, Ca.	12 yrs.

(continued)

TABLE B-1 (continued)

Research No.	Address	Length of Time at Address
327	Thousand Oaks, Ca.	13 yrs.
328	Gary, Ind.	1 yr.
330	San Francisco, Ca.	18 yrs.
336	Dallas, Tx.	13 yrs.
342	West Hempstead, NY.	15 yrs.
344	Port Washington, NY.	12 yrs.
346	Escondido, Ca.	3 mos.
348	New York, NY.	7 yrs.
350	Agena, Guam	14 yrs.
352	Carmel, Ca.	5 yrs.
354	Bloomfield Hills, Mi.	10 yrs.
356	Youngstown, Oh.	18 yrs.
360	Cupertino, Ca.	18 yrs.
362	Palo Alto, Cal.	15 yrs.
364	Pago Pago, Am. Samoa	3 mos.
370	Stanford, Ct.	18 yrs.
372	Piedmont, Ca.	18 yrs.
374	Wilton, Ct.	18 yrs.
376	Columbia, Mo.	6 mos.
378	Piedmont, Ca.	18 yrs.

TABLE B-2. HOME ADDRESSES OF IN-BASIN FEMALES

Research No.	Address	Length of Time at Address
205	Los Angeles, Ca.	18 yrs.
207	Los Angeles, Ca.	18 yrs.
209	Arcadia, Ca.	19 yrs.
211	Los Angeles, Ca.	1 yr.
216	Redondo Beach, Ca.	12 yrs.
229	Hollywood, Ca.	20 yrs.
232	Upland, Ca.	7 yrs.
235	Covina, Ca.	12 yrs.
241	Los Angeles, Ca.	6 yrs.
245	Torrance, Ca.	20 yrs.
251	Northridge, Ca.	19 yrs.
255	Covina, Ca.	10 yrs.
261	Glendora, Ca.	10 yrs.
271	Los Angeles, Ca.	3 yrs.
273	Marina Delrey, Ca.	2 mos.
277	Los Angeles, Ca.	12 yrs.
281	North Hollywood, Ca.	16 yrs.
287	Los Angeles, Ca.	15 yrs.
289	Monterey Park, Ca.	10 yrs.
295	Monterey Park, Ca.	17 yrs.
297	Granada Hills, Ca.	16 yrs.
301	Los Angeles, Ca.	9 yrs.
309	Long Beach, Ca.	3 mos.
316	Riverside, Ca.	18 yrs.
329	Whittier, Ca.	2 yrs.
333	Arcadia, Ca.	7 yrs.
338	Redondo Beach, Ca.	18 yrs.
341	Los Angeles, Ca.	7 yrs.
343	Los Angeles, Ca.	24 yrs.
345	Los Angeles, Ca.	19 yrs.

(continued)

TABLE B-2 (continued)

Research No.	Address	Length of Time at Address
347	Van Nuys, Ca.	18 yrs.
357	Los Angeles, Ca.	2 yrs.
358	Long Beach, Ca.	3 mos.
361	Covina, Ca.	18 yrs.
363	Arcadia, Ca.	18 yrs.
366	Redlands, Ca.	5 yrs.
367	Los Angeles, Ca.	2 yrs.
369	Los Angeles, Ca.	9 yrs.
373	San Marino, Ca.	6 yrs.
377	Woodland Hills, Ca.	10 yrs.
379	Los Angeles, Ca.	17 yrs.
383	San Marino, Ca.	10 yrs.
385	Los Angeles, Ca.	18 yrs.
391	San Gabriel, Ca.	13 yrs.
393	La Mirada, Ca.	13 yrs.
397	Duarte, Ca.	8 yrs.
399	Long Beach, Ca.	17 yrs.
401	Newport Beach, Ca.	1 yr.
403	Whittier, Ca.	13 yrs.
405	Los Angeles, Ca.	8 yrs.
407	Pomona Valley, Ca.	15 yrs.
409	Woodland Hills, Ca.	1 yr.
411	Long Beach, Ca.	3 yrs.
413	Los Angeles, Ca.	1 yr.
415	Rosemead, Ca.	16 yrs.

TABLE B-3. HOME ADDRESSES OF OUT-OF-BASIN MALES

Research No.	Address	Length of Time at Address
2	Lancaster, Co.	8 yrs.
4	Elmira, NY.	17 yrs.
12	Maricopa, Ca.	2 yrs.
14	Idaho Falls, Id.	3 yrs.
16	San Diego, Ca.	5 yrs.
18	West Hempstead, NY.	17 yrs.
24	Scarsdale, NY.	17 yrs.
28	Simi Valley, Ca.	3 yrs.
30	Tucson, Az.	10 yrs.
32	Las Vegas, Nv.	3 yrs.
34	Scottsdale, Az.	10 yrs.
38	Darien, Ct.	12 yrs.
40	Grand Rapids, Mi.	21 yrs.
44	San Francisco, Ca.	17 yrs.
46	New York, NY.	2 yrs.
48	Freehold, NJ.	18 yrs.
64	Oxnard, Ca.	10 yrs.
68	Chicago, Ill.	20 yrs.
70	Palm Springs, Ca.	1 yr.
74	La Jolla, Ca.	2 yrs.
78	San Francisco, Ca.	17 yrs.
80	San Diego, Ca.	18 yrs.
92	Santa Paula, Ca.	18 yrs.
94	Dallas, Tx.	17 yrs.
102	Hana, Hi.	17 yrs.
114	Deerfield, Ill.	5 yrs.
120	Solvang, Ca.	4 yrs.
130	Hawthorne, Nv.	18 yrs.
132	San Diego, Ca.	15 yrs.

(continued)

TABLE B-3 (continued)

Research No.	Address	Length of Time at Address
134	San Diego, Ca.	6 yrs.
136	San Francisco, Ca.	2 yrs.
140	Ventura, Ca.	12 yrs.
142	San Clemente, Ca.	1 yr.
144	Huntington, Ct.	6 mos.
146	Hellertown, Pa.	7 yrs.
148	South Bend, In.	18 yrs.
150	Colorado Springs, Co.	3 mos.
152	Las Vegas, Nv.	16 yrs.
154	Novato, Ca.	18 yrs.
162	El Cajon, Ca.	8 yrs.
170	Boise, Id.	10 yrs.
172	Turlock, Ca.	16 yrs.
176	Stamford, Ct.	5 yrs.
178	Honolulu, Hi.	18 yrs.
182	Mariposa, Ca.	10 yrs.
184	Honolulu, Hi.	18 yrs.
188	Palatine, Ill.	11 yrs.
190	Scottsdale, Az.	9 yrs.
192	Ventura, Ca.	2 yrs.

TABLE B-4. HOME ADDRESSES OF IN-BASIN MALES

Research No.	Address	Length of Time at Address
1	Gardena, Ca.	18 yrs.
5	Gardena, Ca.	20 yrs.
9	Monterey Park, Ca.	19 yrs.
11	North Hollywood, Ca.	9 yrs.
13	Gardena, Ca.	3 mos.
15	Santa Fe Springs, Ca.	15 yrs.
19	Gardena, Ca.	20 yrs.
20	Rolling Hills, Ca.	15 yrs.
23	Gardena, Ca.	8 yrs.
39	La Habra, Ca.	16 yrs.
47	Santa Ana, Ca.	20 yrs.
51	Arcadia, Ca.	16 yrs.
53	El Monte, Ca.	18 yrs.
65	Van Nuys, Ca.	16 yrs.
75	Pomona Valley, Ca.	6 yrs.
77	Bellflower, Ca.	11 yrs.
81	Downey, Ca.	17 yrs.
82	Long Beach, Ca.	7 yrs.
85	Altadena, Ca.	4 yrs.
97	San Fernando, Ca.	7 yrs.
99	Los Angeles, Ca.	14 yrs.
108	Corona del Mar, Ca.	7 yrs.
109	Westminster, Ca.	3 yrs.
111	Los Angeles, Ca.	6 yrs.
115	Sepulveda, Ca.	19 yrs.
117	Glendale, Ca.	13 yrs.
127	San Pedro, Ca.	4 yrs.
131	Los Angeles, Ca.	12 yrs.
133	Los Angeles, Ca.	17 yrs.
135	North Hollywood, Ca.	15 yrs.

(continued)

TABLE B-4 (continued)

Research No.	Address	Length of Time at Address
137	Los Angeles, Ca.	12 yrs.
149	South Gate, Ca.	6 mos.
155	Hermosa Beach, Ca.	2 yrs.
157	Wilmington, Ca.	11 yrs.
159	Granada Hills, Ca.	10 yrs.
161	Arcadia, Ca.	11 yrs.
164	Downey, Ca.	10 yrs.
169	South Gate, Ca.	5 yrs.
171	Pasadena, Ca.	18 yrs.
181	Anaheim, Ca.	11 yrs.
183	Rolling Hills, Ca.	4 yrs.
185	Arcadia, Ca.	10 yrs.
187	Arcadia, Ca.	9 yrs.
193	Monterey Park, Ca.	2 yrs.
195	Walnut, Ca.	7 yrs.
197	Claremont, Ca.	3 mos.
501	Los Angeles, Ca.	7 yrs.

APPENDIX C

Summary of Individual Samples Counted

APPENDIX C

TABLE C-1. IN-BASIN MALE STUDENT SAMPLES COUNTED BY DATE COLLECTED AND SUBJECT CODE NUMBER

Code No.	10/74	2/75	5/75	10/75	5/76	Total
1	x	x	x	x	x	5
5	x	x	x	x	x	5
7	x	x	-	-	-	2
9	x	x	x	x	-	4
11	x	x	x	x	x	5
13	x	x	x	x	x	5
15	x	x	x	x	-	4
19	x	x	x	x	-	4
20	x	x	x	x	x	5
21	x	x	-	-	-	2
23	x	x	x	x	-	4
25	x	x	-	-	-	2
39	x	x	x	x	x	5
43	x	x	x	-	-	3
47	x	x	x	x	-	4
51	x	x	x	x	-	4
53	x	x	x	x	x	5
55	x	x	x	-	-	3
57	x	x	x	-	-	3
61	x	-	-	-	-	1
63	x	x	x	-	-	3
65	x	x	x	x	-	4
75	x	x	x	x	x	5
77	x	x	x	x	-	4
81	x	x	x	x	-	4
82	x	x	x	x	-	4
85	x	x	x	x	-	4
97	x	x	x	x	x	5
99	x	x	x	x	-	4
108	x	x	x	x	x	5
109	x	x	x	x	-	4
111	x	x	x	x	-	4
115	x	x	x	x	-	4
117	x	x	x	x	x	5
127	x	x	x	x	-	4
131	x	x	x	x	-	4
133	x	x	x	x	-	4
135	x	x	x	x	x	5
137	x	x	x	x	-	4
145	x	-	-	-	-	1
149	x	x	x	x	-	4
155	x	x	x	x	x	5
157	x	x	x	x	x	5
159	x	x	x	x	-	4
161	x	x	x	x	-	4
163	x	x	x	-	-	3

(continued)

TABLE C-1 (continued)

Code No.	10/74	2/75	5/75	10/75	5/76	Total
164	x	x	x	x	x	5
169	x	x	x	x	-	4
171	x	x	x	x	-	4
173	x	-	-	-	-	1
175	x	x	x	-	-	3
177	x	-	-	-	-	1
179	x	x	x	-	-	3
181	x	x	x	x	-	4
183	x	x	x	x	-	4
185	x	x	x	x	-	4
187	x	x	x	x	x	5
189	x	-	-	-	-	1
191	x	-	-	-	-	1
193	x	x	x	x	-	4
195	x	x	x	x	-	4
197	x	x	x	x	-	4
199	x	x	x	-	-	3
501	x	x	x	x	-	4
Total	64	58	55	47	16	240

TABLE C-2. IN-BASIN FEMALE STUDENT SAMPLES COUNTED BY DATE COLLECTED AND SUBJECT CODE NUMBER

Code No.	10/74	2/75	5/75	10/75	5/76	Total
203	x	x	x	-	-	3
205	x	x	x	x	-	4
207	x	x	x	x	-	4
209	x	x	x	x	x	5
211	x	x	x	x	-	4
216	x	x	x	x	x	5
229	x	x	x	x	x	5
232	x	x	x	x	-	4
235	x	x	x	x	x	5
241	x	x	x	x	x	5
245	x	x	x	x	-	4
251	x	x	x	x	x	5
255	x	x	x	x	-	4
261	x	x	x	x	-	4
269	x	x	x	-	-	3
271	x	x	x	x	-	4
273	x	x	x	x	x	5
277	x	x	x	x	-	4
278	x	x	x	-	-	3
281	x	x	x	x	x	5
285	x	x	x	-	-	3
287	x	x	x	x	x	5
289	x	x	x	x	-	4
295	x	x	x	x	-	4
297	x	x	x	x	x	5
301	x	x	x	x	-	4
309	x	x	x	x	-	4
315	x	x	x	-	-	3
316	x	x	x	x	-	4
329	x	x	x	x	-	4
333	x	x	x	x	-	4
337	x	x	x	-	-	3
338	x	x	x	x	-	4
341	x	x	x	x	-	4
343	x	x	x	x	-	4
345	x	x	x	x	-	4
347	x	x	x	x	-	4
357	x	x	x	x	-	4
358	x	x	x	x	-	4
359	x	x	x	-	-	3
361	x	x	x	x	-	4
363	x	x	x	x	-	4
366	x	x	x	x	-	4
367	x	x	x	x	x	5
369	x	x	x	x	-	4

(continued)

TABLE C-2 (continued)

Code No.	10/74	2/75	5/75	10/75	5/76	Total
373	x	x	x	x	-	4
377	x	x	x	x	-	4
379	x	x	x	x	-	4
381	x	x	x	-	-	3
383	x	x	x	x	-	4
385	x	x	x	x	x	5
387	x	x	x	-	-	3
389	x	x	x	-	-	3
391	x	x	x	x	-	4
393	x	x	x	x	-	4
397	x	x	x	x	x	5
399	x	x	x	x	-	4
401	x	x	x	x	-	4
403	x	x	x	x	-	4
405	x	x	x	x	-	4
407	x	x	x	x	x	5
409	x	x	x	x	x	5
411	x	x	x	x	x	5
413	x	x	x	x	x	5
415	x	x	x	x	-	4
Total	65	65	65	55	17	267

TABLE C-3. OUT-OF-BASIN MALE STUDENT SAMPLES COUNTED BY DATE COLLECTED AND SUBJECT CODE NUMBER

Code No.	10/74	2/75	5/75	10/75	5/76	Total
2	x	x	x	x	-	4
4	x	x	x	x	x	5
10	x	x	-	-	-	2
12	x	x	x	x	x	5
14	x	x	x	x	-	4
16	x	x	x	x	-	4
18	x	x	x	x	-	4
22	x	x	x	-	-	3
24	x	x	x	x	x	5
26	x	-	-	-	-	1
28	x	x	x	x	-	4
30	x	x	x	x	-	4
32	x	x	x	x	x	5
34	x	x	x	x	-	4
38	x	x	x	x	-	4
40	x	x	x	x	-	4
44	x	x	x	x	-	4
46	x	x	x	x	-	4
48	x	x	x	x	x	5
52	x	-	-	-	-	1
56	x	-	-	-	-	1
58	x	x	x	-	-	3
60	x	x	x	-	-	3
64	x	x	x	x	-	4
68	x	x	x	x	x	5
70	x	x	x	x	-	4
74	x	x	x	x	-	4
76	x	-	-	-	-	1
78	x	x	x	x	-	4
80	x	x	x	x	-	4
92	x	x	x	x	x	5
94	x	x	x	x	-	4
100	x	x	x	-	-	3
102	x	x	x	x	-	4
104	x	x	x	-	-	3
114	x	x	x	x	x	5
116	x	-	-	-	-	1
120	x	x	x	x	x	5
122	x	x	-	-	-	2
124	x	x	-	-	-	2
130	x	x	x	x	-	4
132	x	x	x	x	-	4
134	x	x	x	x	-	4
136	x	x	x	x	-	4
140	x	x	x	x	x	5

(continued)

TABLE C-3 (continued)

Code No.	10/74	2/75	5/75	10/75	5/76	Total
142	x	x	x	x	x	5
144	x	x	x	x	-	4
146	x	x	x	x	x	5
148	x	x	x	x	-	4
150	x	x	x	x	x	5
152	x	x	x	x	-	4
154	x	x	x	x	x	5
158	x	x	x	-	-	3
162	x	x	x	x	-	4
170	x	x	x	x	-	4
172	x	x	x	x	x	5
176	x	x	x	x	x	5
178	x	x	x	x	x	5
180	x	-	-	-	-	1
182	x	x	x	x	-	4
184	x	x	x	x	-	4
188	x	x	x	x	-	4
190	x	x	x	x	-	4
192	x	x	x	x	x	5
Total	64	58	55	49	18	244

TABLE C-4. OUT-OF-BASIN FEMALE STUDENT SAMPLES COUNTED BY DATE COLLECTED AND SUBJECT CODE NUMBER

Code No.	10/74	2/75	5/75	10/75	5/76	Total
208	x	x	x	x	-	4
210	x	x	x	x	x	5
212	x	x	x	x	-	4
214	x	x	x	x	-	4
218	x	x	x	-	-	3
222	x	x	x	x	x	5
226	x	x	x	-	-	3
228	x	x	x	x	-	4
230	x	x	x	x	x	5
234	x	x	x	x	x	5
236	x	x	x	x	x	5
238	x	-	-	-	-	1
240	x	x	x	x	-	4
244	x	x	x	x	x	5
246	x	x	x	x	-	4
248	x	x	x	x	-	4
249	x	x	x	x	-	4
250	x	-	-	-	-	1
252	x	x	x	-	-	3
254	x	-	-	-	-	1
258	x	x	x	x	-	4
266	x	x	x	x	-	4
272	x	-	-	-	-	1
280	x	x	x	-	-	3
286	x	x	x	x	-	4
288	x	x	x	x	-	4
290	x	-	-	-	-	1
292	x	x	x	x	-	4
298	x	x	x	x	-	4
300	x	x	x	x	-	4
302	x	-	-	-	-	1
304	x	x	x	x	x	5
308	x	x	x	-	-	3
310	x	x	x	x	x	5
312	x	x	x	x	x	5
314	x	x	x	x	x	5
318	x	x	x	x	x	5
320	x	x	x	x	-	4
322	x	x	x	x	-	4
324	x	-	-	-	-	1
326	x	x	x	x	-	4
327	x	x	x	x	-	4
328	x	x	x	x	-	4
330	x	x	x	x	-	4
336	x	x	x	x	-	4
342	x	x	x	x	-	4

(continued)

TABLE C-4 (continued)

Code No.	10/74	2/75	5/75	10/75	5/76	Total
344	x	x	x	x	-	4
346	x	x	x	x	x	5
348	x	x	x	x	-	4
350	x	x	x	x	-	4
352	x	x	x	x	x	5
354	x	x	x	x	x	5
356	x	x	x	x	-	4
360	x	x	x	x	-	4
362	x	x	x	x	-	4
364	x	x	x	x	-	4
368	x	x	x	-	-	3
370	x	x	x	x	-	4
372	x	x	x	x	x	5
374	x	x	x	x	-	4
376	x	x	x	x	x	5
378	x	x	x	x	x	5
380	x	x	-	-	-	2
Total	63	56	55	49	17	240

APPENDIX D

Chromosome Analysis Scan Sheet

APPENDIX D

CHROMOSOME ANALYSIS SCAN SHEET

Page-__
Name of Study______________________ Microscope__________ Date____________ Culture Time__________
Number__________ SSN______________ Sex________ Age________

	CELL NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Subtotals
A-1																										
A-2																										
A-3																										
B																										
C																										
D																										
E																										
F																										
G																										
COUNT																										
COORDINATES																										
																								TOTAL→		
PHOTO-X																										

KEY B= Break G= Gap P= Short Arm q= Long Arm C= Centromere

COMMENTS ____

DONE BY__________________ DATE________________

SSG Form 5

APPENDIX E

Satellite Association Chromosome Analysis:

E-1. Scan Sheet

E-2. Association Criteria

APPENDIX E-1

Genetic Toxicology Section
Appendix 5

CHROMOSOME ANALYSIS SCAN SHEET
for Satellite Association

Slide Number ______ Study ______ Date ______
Culture Time Hours ______ Sex ______ Age ______
Microscope Number ______ Technician ______

Cell	Coordinates	Chromosome Number	D-D Assoc	D-G Assoc	G-G Assoc	Total Assoc	Gap	Iso-Gap	Break	Other Rings & Dicentrics
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

Key: B=Break G=Gap p=Short Arm q=Long Arm

APPENDIX E-2

Association Criteria

Two or more acrocentric chromosomes were considered 'associated' when the following conditons were fulfilled:

(1) The distance between two acrocentric chromosomes did not exceed the length of the long arm of the largest G chromosome of the mitosis in question

(2) If the short arms of the chromosomes were connected by clearly visible thread-like structures, larger distances were accepted

(3) Larger distances, up to the length of the long arm of a D-chromosome, were also accepted when the associating partners lie exactly on the same longitudinal axis

(4) The short arms of the second, or any further, associating acrocentric chromosome, pointed towards those of the first and did not lie below the 'centromere-line' of the first chromosome. We defined 'centromere-line' as the line that crosses the centromere perpendicular to the chromosomal longitudinal axis (Fig. 1).

APPENDIX F

F-1. Coding Forms

F-2. Coding Guide

F-3. Coding Sheets -- Aberrations and Satellites

APPENDIX F-1

CODING FORMS - L.A. SMOG STUDY

Research No. ______ [1-3]   Group __ [4]   Rescan __ [5]   Record 1 [6]   Page 1 of 2

Question					
2	Date of Birth:	Day ____ [10 11]	Month ____ [12 13]	Year ____ [14 15]	Age ____ [16 17]
3	Sex	__ [18]	1=Male 2=Female		
4	Zip Code	______ [19 23]			
7	Radiation Therapy	__ [24]	1=Yes 2=No 9=Unknown		
8	Radioactive Substance	__ [25]	1=Yes 2=No 9=Unknown		

Question	X-rays	Number	When	
9	Upper Extremities	__ [26]	__ [27]	1=In last 5 years 2=More than 5 years ago 3=Both of the above 9=Unknown
	Lower Extremities	__ [28]	__ [29]	
	Head, Neck	__ [30]	__ [31]	
	Trunk	__ [32]	__ [33]	
	Unknown, other	__ [34]	__ [35]	

Question			
10	Thyroid Test	__ [36]	1=Yes 2=No 9=Unknown
11	Tuberculosis Treatment	__ [37]	1=Yes 2=No 9=Unknown

Question	Routine Drugs-Class	No. of Drugs Per Class	Months Taken 1=<2 4=9-12 2=2-4 5=>12 3=5-8 9=Unknown	When Taken 1-In last year 2=>1 Year ago 3=Both 9=Unknown
12	Amphetamines	__ [38]	__ [39]	__ [40]
	Analgesics	__ [41]	__ [42]	__ [43]
	Antibiotics	__ [44]	__ [45]	__ [46]
	Antihistamines	__ [47]	__ [48]	__ [49]
	Hormones	__ [50]	__ [51]	__ [52]
	Tranquilizers	__ [53]	__ [54]	__ [55]
	Other	__ [56]	__ [57]	__ [58]

APPENDIX F-1 (continued)

Research No. ______ Group ___ Rescan ___ Record 1 Page 2 of 2

Question			
13	Asthma	___ 59	1=Yes 2=No 9=Unknown
	Bronchitis	___ 60	1=Yes 2=No 3=Not Applicable 9=Unknown
14	Drug Allergy-Class	1=Yes 2=No 9=Unknown	
	Analgesics	___ 61	
	Antibiotics	___ 62	
	Other	___ 63	
15	Recent infection	___ 64	1=Yes 2=No 9=Unknown
	Symptoms	1=Yes 2=No 3=Not applicable 9=Unknown	
	Nasal congestion	___ 65	
	Chest Congestion	___ 66	
	Headache	___ 67	
	G.I. Upset	___ 68	
	Other	___ 69	
16	Current Drugs - Class	No. of Drugs per Class	
	Amphetamines	___ 70	
	Analgesics	___ 71	
	Antibiotics	___ 72	
	Antihistamines	___ 73	
	Hormones	___ 74	
	Tranquilizers	___ 75	
	Other	___ 76	

APPENDIX F-1 (continued)

Research No. ____ (1-3)	Group ____ (4)	Rescan ____ (5)	Record 2 (6)

Question		Feb-May 74 74	May-Oct 74 74	Oct-Feb 74 75	Feb-May 75 75	May-Oct 75 75
17	Rash 1 = Drug Related 2 = Viral Origin 3 = Other 4 = None 9 = Unknown	10	11	12	13	14
18	Mononucleosis 1 = Yes 2 = No 9 = Unknown	15	16	17	18	19
19	Hepatitis 1 = Yes, Serum 2=Yes, Infectious 3=Yes, type unknown 4=No 9=Unknown	20	21	22	23	24
20	Illness 1 = Viral 2 = Other 3 = None 9 = Unknown	25	26	27	28	29
21	Hay Fever 1 = Yes, drugs taken 2 = Yes, no drugs 3 = No 9 = Unknown	30	31	32	33	34
22	Birth Control Pills 1 = Yes 2 = No 3 = Not Applicable 9 = Unknown	35	36	37	38	39
23	Drugs Taken - Class 1 = Yes 2 = No/Unknown					
	Amphetamines	[illegible]	41	42	43	44
	Analgesics	[illegible]	[illegible]	47	48	49
	Antibiotics	50	[illegible]	52	53	54
	Antihistamines	55	56	57	58	59
	Hormones	60	61	62	[illegible]	[illegible]
	Tranquilizers	[illegible]	66	67	[illegible]	69
	Other	70	71	72	73	[illegible]

APPENDIX F-1 (continued)

Research No. ______ (1-3) Group ____ (4) Rescan ____ (5) Record 3 (6)

Question			Feb-May 74 74	May-Oct 74 74	Oct-Feb 74 75	Feb-May 75 75	May-Oct 75 75
24	Vaccinations and Shots	1 = Yes 2 = No/Unknown					
	Smallpox		__ 10	__ 11	__ 12	__ 13	__ 14
	Tetanus		__ 15	__ 16	__ 17	__ 18	__ 19
	D-P-T		__ 20	__ 21	__ 22	__ 23	__ 24
	Polio		__ 25	__ 26	__ 27	__ 28	__ 29
	Yellow Fever		__ 30	__ 31	__ 32	__ 33	__ 34
	Cholera		__ 35	__ 36	__ 37	__ 38	__ 39
	Flu		__ 40	__ 41	__ 42	__ 43	__ 44
	Mumps		__ 45	__ 46	__ 47	__ 48	__ 49
	Gammaglobulin		__ 50	__ 51	__ 52	__ 53	__ 54
	Allergy Shots		__ 55	__ 56	__ 57	__ 58	__ 59

APPENDIX F-1 (continued)

Research No. ____ (1-3) Group ____ (4) Rescan ____ (5) Record 4 (6)

Question		Feb-May 74 74	May-Oct 74 74	Oct-Feb 74 75	Feb-May 75 75	May-Oct 75 75
25	Chemical Exposure 1 = Known Mutagens 2 = Suspected Mutagens 3 = Non Mutagens 4 = None 9 = Unknown	10	11	12	13	14
26	Cigarettes per Day 1 = None 2 = < 1 - Not every day 3 = 1-4 4 = 5-14 5 = 15-24 6 = 25+ 9 = Unknown	15	16	17	18	19
27	Pipe/Cigar 1 = Neither 2 = Pipe 3 = Cigar 4 = Both 9 = Unknown	20	21	22	23	24
28	Marijuana 1 = Yes 2 = No 9 = Unknown	25	26	27	28	29

Question	Exposure to Hazards	1 = Yes 2 = No/Unknown	Full Time Months Exposure
29	Ag Chemicals, pesticides	30	31 32
	Automobile Gases & Fumes	33	34 35
	Laboratory Chemicals	36	37 38
	Radioactive Chemicals	39	40 41
	Miscellaneous Dusts	42	43 44
	Miscellaneous Gases & Fumes	45	46 47
	Miscellaneous Other Chemicals	48	49 50

Research No. ____ (1–3) Group __ (4) Rescan __ (5) Record 5 (6)

Question			
4	1975 Fall School Residence	Zipcode ______ (10–14)	
		Student Housing __ (15)	1=Yes 2=No
		Miles __.__ (16–18)	Unknown=99.9
30	1975 Summer Residences	Zipcode ______ (19–23)	Weeks __ (24–25)
		Zipcode ______ (26–30)	Weeks __ (31–32)
		Zipcode ______ (33–37)	Weeks __ (38–39)
31	1974-1975 School Residences	Zipcode ______ (40–44)	Months __ (45)
		Student Housing __ (46)	1=Yes 2=No
		Miles __.__ (47–49)	99.9=Unknown
		Zipcode ______ (50–54)	Months __ (55)
		Student Housing __ (56)	1=Yes 2=No
		Miles __.__ (57–59)	99.9=Unknown
32	1974 Summer Residences	Zipcode ______ (60–64)	Weeks __ (65–66)
		Zipcode ______ (67–71)	Weeks __ (72–73)
		Zipcode ______ (74–78)	Weeks __ (79–80)

APPENDIX F-1 (continued)

Research No. ______ (1-3) Group ____ (4) Rescan ____ (5) Record _6_ (6)

Question

33 Permanent Addresses in last 5 Years - Code most recent first

Type: 1 = Rural Farm 2 = Rural Non-Farm 3 = City 4 = Suburb

Zipcode	Months	Type
10-14	15-16	17
18-22	23-24	25
26-30	31-32	33
34-38	39-40	41
42-46	47-48	49
50-54	55-56	57
58-62	63-64	65
66-70	71-72	73

No. of years in last 10 years that person lived in SMSA (> 1 million) ____ (74-75)

34 Ethnic Background ____ (76)

1=Black
2=Latin American
3=White
4=Oriental
5=Other
6=Non-Citizen
7=American Indian

APPENDIX F-2

CODING GUIDE - LOS ANGELES SMOG STUDY QUESTIONNAIRE

Question	Record	Columns	Explanation
Research Number	All	1-3	3 digit research number assigned to subject
Group	All	4	1=In basin male 2=In basin female 3=Out of basin male 4=Out of basin female
Rescan	All	5	1=Not in rescan group 2=In rescan group
Record	All	6	This is precoded on each coding form
1. Name	-	-	Not coded
2. Birth Date	1	10-15	Two digit day month, and year (include leading zeroes)
Age	1	16-17	Compute age of October 1, 1975
3. Sex	1	18	1=Male 2=Female 3=Male 4=Female (without questionnaires)
4. Address	1	19-23	Code only 5 digit zipcode. The rest of the data should be entered on Record 5 If student housing=Yes, miles=0 If student housing=No, 1 block=.1 mile
7. Radiation Therapy	1	24	1=Yes 2=No 9=Unknown
8. Radioactive Substance	1	25	1=Yes 2=No 9=Unknown
9. X-rays	1	26-35	Code the total number of incidents of x-rays in each category. If more than 8 code 8. If unknown code 9, if zero code 0. Check whether the x-rays in each category occurred in the last 5 years, more than 5 years ago, or at both times. If no x-rays occurred in a category, leave the "when" column blank. (Shoulder recorded as trunk).
10. Thyroid Test	1	36	1=Yes 2=No 9=Unknown (routine thyroxin level test coded yes.)
11. TB Treatment	1	37	1=Yes 2=No 9=Unknown
12. Routine Drugs Taken	1	38-58	Classify drugs by drug class and code number in each class (Reference: <u>Physician's Desk Reference</u>) Code zero when no drugs in a class were taken and leave months taken and when taken blank. For months taken, code total months during which any drug in the class was taken. For when taken, code when any drug in class was taken. Use October 1, 1974 for cutoff point for > 1 year ago.

Question	Record	Columns	Explanation
12. Routine Drugs Taken (continued)			Coding decisions: Antibiotics="face pills" Antihistamines=histamine/inhalant Hormones=cortisone Tranquilizer=anti-spasmodic Other=Vitamins,thyroid, anesthetic, cocaine, tedral, allergy shots
13. Asthma	1	59	1=Yes 2=No 9=Unknown
Bronchitis	1	60	1=Yes 2=No 9=Unknown Code 3=Not applicable when answer to previous question is yes.
14. Drug Allergy	1	61-63	Using the same drug classes as Question 12, code YES if allergic to one or more drug in class. Code NO for each class if no drug allergies are checked. Unknown=9 (Compazine, sodium-pentothal recorded as other.)
15. Recent Infection	1	64-69	1=Yes 2=No 9=Unknown If answer is NO, code not applicable for symptoms If answer is unknown, code UNKNOWN for symptoms If answer is YES, code YES or NO for symptoms
16. Current Drugs	1	70-76	Use drug classes for Question 12 and code the number of drugs per class. Eight or more drugs should be coded 8. No drugs should be coded zero. Unknown should be coded 9. (Birth control coded hormone, if indicated; thyroid, Renese, Nyquil, Ionamin coded other.)
17. Rash	2	10-14	For each period code whether rash was caused by drug-1, of viral origin=2 (reference: Dorland's Medical Dictionary), of other or unknown etiology=3, none=4, or unknown=9. (Hives, pool infection, skin infection=other.)
18. Mononucleosis	2	15-19	For each period: 1=Yes 2=No 9=Unknown
19. Hepatitis	2	20-24	For each period: 1=Yes, serum hepatitis 2=Yes, infectious hepatitis, 3=Yes, type not known, 4=No hepatitis, 9=Unknown
20. Illness	2	25-29	For each period: Code 1 if illness is viral (Reference. Dorland's Medical Dictionary Code 2 if illness is of any other type Code 3 if no illness, Code 9 if unknown (Strep throat, ear infection, headaches=other)

Question	Record	Columns	Explanation
21. Hay Fever	2	30-34	For each period: 1=Yes, drugs taken, 2=Yes, no drugs taken, 3=No, hay fever, 9=Unknown (Allergy shots coded as drugs taken)
22. Birth Control Pills	2	35-39	For each period: For males code 3=Not applicable For females 1=Yes 2=No 9=Unknown
23. Drugs Taken	2	40-74	Using the drug classes from Question 12, for each period Code 1 if any drug in a class was taken, code 2 if no drugs in a class were mentioned. Coding decisions: (No-doz not coded) Amphetamines=diet pills Analgesics=Emphazil Antihistamines=Emphazil, decongestants Tranquilizers=Compazine Other=Cocaine, vitamins, iron, cough syrup, diuretics, anesthetics, Nyquil, Exidrex
24. Vaccinations and Shots	3	10-59	For each period, code a 1 if a vaccination or shot was received and code 2 if no vaccination or shot was mentioned.
25. Chemical Exposure	4	10-14	For each period, if employment involved: Known mutagens code 1, suspected mutagens code 2, non-mutagens code 3. (Reference: Chemical Mutagenesis, Environmental Mutagen Information Center). If nothing is mentioned code 4. (Known mutagens: Formalin, mercuric chloride Suspected mutagens: Lab chemicals Non-mutagens: Muratic acid, chlorine)
26. Cigarettes	4	15-19	For each period, code average number of cigarettes smoked per day 1=Non-smoker 2=Less than 1 per day, not every day 3=1-4 per day 4=5-14 per day (1/2 pack) 5=15-24 per day 6=25 or more per day (1 p[illegible]) (more than 1 pack) 7=Smoker, but quantity not given 9=Unknown
27. Pipe/Cigar	4	20-24	For each period, code item smoked 1=Neither pipe or cigar 2=Pipe only 3=cigars only 4=Pipe and cigars 9=Unknown
28. Marijuana	4	25-29	For each period code 1 if marijuana smoked, code 2 if not smoked, code 9 if unknown.

APPENDIX F-2 (continued)

Question	Record	Columns	Explanation
29. Employment Exposure to Hazards	4	30-50	For each class of hazard, code 1 if person had any occupational exposure and then code number of months exposed (2 digits) For anything greater than 1 week code one month. If no exposure is mentioned code 2 and leave months exposed blank. If exposure is unknown, code 99. (Miscellaneous other chemicals: x-ray developer, printing chemicals, paint and thinner, cleaning fluid, dental lab chemicals, liquid nitrogen, rubber, acrylic monomers)
4. Fall 1975 School Residence	5	10-18	Code dates from first page of questionnaire. Code five digit zipcode. Code 1 if student housing, code 2 if private housing, code 9 if unknown. Code miles to campus to the nearest tenth of a mile (xx.x). The decimal is preprinted on the coding form. Unknown=99.9
30. 1976 Summer Residences	5	19-39	Code 5 digit zipcodes for three residences. If more than three, code the three with the longest length of residence. Code Mexico 99991, Canada 99992, South America 99993, Europe 99994, Caribbean and Central America 99995, [illegible] South Pacific 99997, Africa 99998. Code number of weeks at each location. Code the entire [illegible] more complete information [illegible]. If weeks are unknown code 99. If no response leave blank.
31. 1971-1975 School Residences	5	[illegible]	Code as in Question 4 for the two residences [illegible] longest length of stay. Code [illegible] at each location (1 digit).
32. 197[illegible] Summer Residences	5	60-80	Code as in Question 30
33. Permanent Addresses	6	10-[illegible]	Code [illegible] Question 30. Code the most recent [illegible] and code all addresses in [illegible] last [illegible] years. (If more than [illegible] same area). Code number of months in each location (2 digits, include leading zeroes). Code 99 if unknown Code farm type. 1=Rural farm 2=Rural non-farm 3=City 4=Suburban 9=Not given/unknown

APPENDIX F-2 (continued)

Question	Record	Columns	Explanation
33. Permanent Addresses (continued)	6	10-75	Code total number of years out [illegible] 10 years that person lived in SMSA (> 1,000,000 population) (Reference: Rand McNally Green Guide). If 10 years are not indicated, code 9.
34. Ethnic Background	6	76	Code 1 digit ethnic background 9=Unknown. (Latin American=Spanish origin, Mexican, Chicano; Oriental=Asian or Pacific Islander)

APPENDIX F-3

CODING SHEET - L.A. SMOG STUDY - ABERRATIONS

Research No. 1-3 Record No. 7 / 4

Sample Time	Number Abnormal Cells	Number Breaks	Number Gaps	Number Isogaps	Number Hypodiploid	Number Hyperdiploid	Number Stable Changes	Number Endoredup-lication
OCT. 74	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20
FEB. 75	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
MAY 75	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52
OCT 75	53-54	55-56	57-58	59-60	61-62	63-64	65-66	67-68

APPENDIX F-3 (continued)

CODING SHEET - L.A. SMOG STUDY - ABERRATIONS

RESCAN

Research No. ___ (1-3)   Record No. 8 (4)

Sample Time	Number Abnormal Cells	Number Breaks	Number [illegible]	Number Isogaps	Number Hypodiploid	Number Hyperdiploid	Number Stable Changes	Number Endoredup-lication
MAY 76 RESCAN	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20
Oct 74 RESCAN	21-22	23-24	25-26	27-28	29-30	31-32	33-34	35-36
Feb 75 RESCAN	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52
May 75 RESCAN	53-54	55-56	57-58	59-60	61-62	63-64	65-66	67-68

APPENDIX F-3 (continued)

CODING SHEET - L.A. SMOG STUDY - SATELLITE ASSOCIATION

Research No. ___ 1-3   Record No. ___ 9 / 4

Sample Time	No. of D's	No. of G's	Groups of 2	Groups of 3	Groups of 4 or more	No. of D-D	No. of D-G	No. of G-G	Cells with No Assn.
OCT 74	5-7	8-9	[illegible]	12-13	14-15	16-17	18-19	20-21	22-23
FEB 75	24-26	27-28	[illegible]	31-32	33-34	35-36	37-38	39-40	41-42
MAY 75	43-45	46-47	48-49	50-51	52-53	54-55	56-57	58-59	60-61
OCT 75	62-64	[illegible]	67-68	69-70	71-72	73-74	75-76	77-78	79-80

APPENDIX F-3 (continued)

CODING SHEET - L.A. SMOG STUDY - SATELLITE ASSOCIATION (continued)

Research No. ____ (1-3)   Record No. 0 (4)

Sample Time	No. of D's	No. of G's	Groups of 2	Groups of 3	Groups of 4 or more	No. of D-D	No. of D-G	No. of G-G	Cells with No Assn.
May 76	5-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	22-23

APPENDIX G

Intergroup Comparisons of Background Variables

Tables G-1 to G-55

Symbol Definitions:

χ^2_m = chi square test between in- and out-of-basin males

χ^2_f = chi square test between in- and out-of-basin females

*,**,*** = statistically significant difference between in-basin and out-of-basin students $p<.05$, $p<.01$, $p<.001$, respectively

APPENDIX G

TABLE G-1. AGE BY SEX DISTRIBUTION

Age (years)	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
<19	6	8	10	6	30
19	17	28	32	33	110
20	10	9	2	4	25
21	9	4	1	2	16
>21	5	6	3	4	18
Total	47	55	48	49	199
Mean	20.1	19.8	19.1	19.4	19.6
Median	20.0	19.0	19.0	19.0	19.0
Range	18-33	18-29	18-22	17-26	17-33

χ^2_m (4 df) = 17.82** χ^2_f (4 df) = 3.35

TABLE G-2. RADIATION THERAPY/RADIOACTIVE SUBSTANCE

Exposure	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No exposure	44	52	45	49	190
Exposure	3	3	3	0	9
Total	47	55	48	49	199

χ^2_m(1 df) = 0.16 χ^2_f(1 df) = 1.15

TABLE G-3. X-RAYS - UPPER EXTREMITIES

No. of X-rays	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
0	36	45	34	37	152
1	7	10	9	7	33
2	3	0	5	5	13
Unknown	1	0	0	0	1
Total	47	55	48	49	199

χ^2_m(2 df) = 0.76 χ^2_f(2 df) = 5.98

TABLE G-4. X-RAYS - LOWER EXTREMITIES

	In-Basin		Out-of-Basin		
No. of X-rays	Males	Females	Males	Females	Total
0	29	45	34	30	138
1	12	9	10	11	42
≥2	5	1	4	8	18
Unknown	1	0	0	0	1
Total	47	55	48	49	199

χ^2_m (2 df) = 0.65 χ^2_f(2 df) = 8.33*

TABLE G-5. X-RAYS - HEAD AND NECK

	In-Basin		Out-of-Basin		
No. of X-rays	Males	Females	Males	Females	Total
0	41	49	44	38	172
≥1	5	6	4	11	26
Unknown	1	0	0	0	1
Total	47	55	48	49	199

χ^2_m(1 df) = 0.00 χ^2_f(1 df) = 1.75

TABLE G-6. X-RAYS - TRUNK

	In-Basin		Out-of-Basin		
No. of X-rays	Males	Females	Males	Females	Total
0	37	46	39	41	163
1	7	4	9	8	28
≥2	2	5	0	0	7
Unknown	1	0	0	0	1
Total	47	55	48	49	199

χ^2_m(2 df) = 2.26 χ^2_f(2 df) = 6.30*

TABLE G-7. THYROID TEST

Thyroid Test	In-Basin Males	Females	Out-of-Basin Males	Females	Total
Yes	0	4	0	7	11
No	47	51	48	42	188
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.00$ $\chi^2_f(1\ df) = 0.71$

TABLE G-8. T-B TREATMENT

T-B Treatment	In-basin Males	Females	Out-of-Basin Males	Females	Total
Yes	0	1	0	0	1
No	47	54	48	49	198
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.00$ $\chi^2_f(1\ df) = 0.00$

TABLE G-9. ROUTINE DRUGS - ANTIBIOTICS

Antibiotics	In-Basin Males	Females	Out-of-Basin Males	Females	Total
No	41	43	42	45	171
Yes	6	12	6	4	28
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.07$ $\chi^2_f(1\ df) = 2.74$

TABLE G-10. ROUTINE DRUGS - ANTIHISTAMINES

Antihistamines	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	47	51	42	48	188
Yes	0	4	6	1	11
Total	47	55	48	49	199

χ^2_m(1 df) = 4.34* χ^2_f(1 df) = 0.62

TABLE G-11. ROUTINE DRUGS - OTHER DRUGS

Other Drugs	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	46	50	43	40	179
Yes	1	5	5	9	20
Total	47	55	48	49	199

χ^2_m(1 df) = 1.53 χ^2_f(1 df) = 1.20

TABLE G-12. ASTHMA

Asthma	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	6	2	3	3	14
No	37	49	40	41	167
Unknown	4	4	5	5	18
Total	47	55	48	49	199

χ^2_m(1 df) = 0.50 χ^2_f(1 df) = 0.03

TABLE G-13. BRONCHITIS

Bronchitis	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	3	1	4	5	13
No	31	41	32	30	134
Not Applicable	6	2	3	2	13
Unknown	7	11	9	12	39
Total	47	55	48	49	199

χ^2_m(1 df) = 0.01 χ^2_f(1 df) = 2.29

TABLE G-14. DRUG ALLERGY - ANTIBIOTICS

	In-Basin		Out-of-Basin		
Drug Allergy	Males	Females	Males	Females	Total
Yes	8	11	6	1	26
No	35	40	36	43	154
Unknown	4	4	6	5	19
Total	47	55	48	49	199

χ^2_m(1 df) = 0.06 χ^2_f(1 df) = 6.32*

TABLE G-15. DRUG ALLERGY - OTHER DRUGS

	In-Basin		Out-of-Basin		
Drug Allergy	Males	Females	Males	Females	Total
Yes	0	4	0	1	5
No	43	47	42	43	175
Unknown	4	4	6	5	19
Total	47	55	48	49	199

χ^2_m(1 df) = 0.00 χ^2_v(1 df) = 0.57

TABLE G-16. RECENT INFECTION

	In-Basin		Out-of-Basin		
Recent Infection	Males	Females	Males	Females	Total
Yes	15	24	17	17	73
No	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

χ^2_m(1 df) = 0.05 χ^2_f(1 df) = 0.38

TABLE G-17. RECENT INFECTION - NASAL CONGESTION

Nasal Congestion	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	14	17	16	10	57
No	1	7	1	7	16
Not Applicable	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.41$ $\chi^2_f(1\ df) = 0.22$

TABLE G-18. RECENT INFECTION - CHEST CONGESTION

Chest Congestion	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	3	2	6	4	15
No	12	22	11	13	58
Not Applicable	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.32$ $\chi^2_f(1\ df) = 0.82$

TABLE G-19. RECENT INFECTION - HEADACHE

Headache	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	4	12	6	6	28
No	11	12	11	11	45
Not Applicable	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.02$ $\chi^2_f(1\ df) = 0.38$

TABLE G-20. RECENT INFECTION - G.I. SYMPTOMS

G.I. Symptoms	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	2	7	4	5	18
No	13	17	13	12	55
Not Applicable	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

χ^2_m(1 df) = 0.08 χ^2_f(1 df) = 0.11

TABLE G-21. RECENT INFECTION - OTHER SYMPTOMS

Other Symptoms	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
Yes	5	10	6	9	30
No	10	14	11	8	43
Not Applicable	28	27	26	27	108
Unknown	4	4	5	5	18
Total	47	55	48	49	199

χ^2_m(1 df) = 0.07 χ^2_f(1 df) = 0.16

TABLE G-22. CURRENT DRUGS - ANALGESICS

Analgesics	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	43	47	42	44	176
Yes	0	4	1	0	5
Unknown	4	4	5	5	18
Total	47	55	48	49	199

χ^2_m(1 df) = 0.00 χ^2_f(1 df) = 1.92

TABLE G-23. CURRENT DRUGS - ANTIBIOTICS

Antibiotics	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	42	44	39	40	165
Yes	1	7	4	4	16
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.85$ $\chi^2_f(1\ df) = 0.15$

TABLE G-24. CURRENT DRUGS - ANTIHISTAMINES

Antihistamines	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	43	46	35	42	166
Yes	0	5	8	2	15
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 6.75^{**}$ $\chi^2_f(1\ df) = 0.34$

TABLE G-25. CURRENT DRUGS - HORMONES

Hormones	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	43	43	43	38	167
Yes	0	8	0	6	14
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.00$ $\chi^2_f(1\ df) = 0.00$

TABLE G-26. CURRENT DRUGS - AMPHETAMINES OR TRANQUILIZERS

Amphetamines or Tranquilizers	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	42	49	43	43	177
Yes	1	2	0	1	4
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.00$ $\chi^2_f(1\ df) = 0.02$

TABLE G-27. CURRENT DRUGS - OTHER DRUGS

Other Drugs	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
No	42	46	42	39	163
Yes	1	5	1	5	12
Unknown	4	4	5	5	18
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.51$ $\chi^2_f(1\ df) = 0.01$

TABLE G-28. RASH DURING STUDY

Time	Rash	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	1	1	0	2
	No	46	49	46	49	190
	Unknown	1	5	1	0	7
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
5/74 to 10/74	Yes	2	1	2	0	5
	No	44	49	45	49	187
	Unknown	1	5	1	0	7
		χ^2_m(1 df) = 0.24		χ^2_f(1 df) = 0.00		
10/74 to 2/75	Yes	0	2	0	1	3
	No	46	50	47	48	191
	Unknown	1	3	1	0	5
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
2/75 to 5/75	Yes	0	1	1	1	3
	No	46	51	46	47	190
	Unknown	1	3	1	1	6
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.43		
5/75 to 10/75	Yes	0	4	0	1	5
	No	46	48	47	46	187
	Unknown	1	3	1	2	7
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.64		
Total (for each Time Period		47	55	48	49	199

TABLE G-29. MONONUCLEOSIS DURING STUDY

Time	Mononucleosis	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	0	2	0	2
	No	46	51	45	49	191
	Unknown	1	4	1	0	6
		χ^2_m(1 df) = 0.49		χ^2_f(1 df) = 0.00		
5/74 to 10/74	Yes	0	0	0	0	0
	No	46	51	47	49	193
	Unknown	1	4	1	0	6
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
10/74 to 2/75	Yes	0	2	0	1	3
	No	46	51	47	48	192
	Unknown	1	2	1	0	4
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
2/75 to 5/75	Yes	0	1	1	1	3
	No	46	52	46	47	191
	Unknown	1	2	1	1	5
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.42		
5/75 to 10/75	Yes	0	0	0	1	1
	No	46	53	47	47	193
	Unknown	1	2	1	1	5
		χ^2_m(1 dg) = 0.00		χ^2_f(1 df) = 0.00		
Total (for each Time period		47	55	48	49	199

TABLE G-30. ILLNESS DURING STUDY

Time	Illness	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	1	0	1	2
	No	45	50	47	48	190
	Unknown	2	4	1	0	7
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.47		
5/74 to 10/74	Yes	1	1	0	1	3
	No	44	50	47	48	189
	Unknown	2	4	1	0	7
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.47		
10/74 to 2/75	Yes	0	1	0	1	2
	No	46	52	47	48	193
	Unknown	1	2	1	0	4
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.43		
2/75 to 5/75	Yes	1	1	0	2	4
	No	45	52	47	46	190
	Unknown	1	2	1	1	5
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.01		
5/75 to 10/75	Yes	0	4	1	4	9
	No	46	49	46	44	185
	Unknown	1	2	1	1	5
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.05		
Total (for each Time Period		47	55	48	49	199

TABLE G-31. HAY FEVER DURING STUDY

Time	Hay Fever	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	5	5	5	2	17
	No	40	46	43	46	175
	Unknown	2	4	0	1	7
	χ^2_m(1 df) = 0.05			χ^2_f(1 df) = 0.49		
5/74 to 10/74	Yes	8	7	6	4	25
	No	37	44	42	44	167
	Unknown	2	4	0	1	7
	χ^2_m(1 df) = 0.18			χ^2_f(1 df) = 0.28		
10/74 to 2/75	Yes	3	9	4	1	17
	No	43	44	44	47	178
	Unknown	1	2	0	1	4
	χ^2_m(1 df) = 0.00			χ^2_f(1 df) = 4.71*		
2/75 to 5/75	Yes	6	8	6	3	23
	No	40	44	42	44	170
	Unknown	1	3	0	2	6
	χ^2_m(1 df) = 0.05			χ^2_f(1 df) = 1.22		
5/75 to 10/75	Yes	8	8	4	4	24
	No	38	44	44	43	169
	Unknown	1	3	0	2	6
	χ^2_m(1 df) = 1.01			χ^2_f(1 df) = 0.54		
Total (for each Time Period		47	55	48	49	199

TABLE G-32. BIRTH CONTROL PILLS DURING STUDY

Time	Birth Control Pills	In-Basin Females	Out-of-Basin Females	Total
2/74 to 5/74	Yes	9	6	15
	No	41	43	84
	Unknown	5	0	5
	χ^2_f(1 df) = 0.27			
5/74 to 10/74	Yes	12	6	18
	No	38	43	81
	Unknown	5	0	5
	χ^2_f(1 df) = 1.58			
10/74 to 2/75	Yes	14	7	21
	No	39	42	81
	Unknown	2	0	2
	χ^2_f(1 df) = 1.61			
2/75 to 5/75	Yes	16	10	26
	No	37	38	75
	Unknown	2	1	3
	χ^2_f(1 df) = 0.72			
5/75 to 10/75	Yes	14	11	25
	No	39	37	76
	Unknown	2	1	3
	χ^2_f(1 df) = 0.03			
Total (for each Time Period)		55	49	104

TABLE G-33. ANALGESICS DURING STUDY

Time	Analgesics	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	15	25	16	17	73
	No	32	30	32	32	126
		χ^2_m(1 df) = 0.01		χ^2_f(1 df) = 0.84		
5/74 to 10/74	Yes	14	25	16	15	70
	No	33	30	32	34	129
		χ^2_m(1 df) = 0.02		χ^2_f(1 df) = 1.83		
10/74 to 2/75	Yes	15	25	17	13	70
	No	32	30	31	36	129
		χ^2_m(1 df) = 0.02		χ^2_f(1 df) = 3.24		
2/75 to 5/75	Yes	16	25	19	17	77
	No	31	30	29	32	122
		χ^2_m(1 df) = 0.12		χ^2_f(1 df) = 0.84		
5/75 to 10/75	Yes	21	30	21	19	91
	No	26	25	27	30	108
		χ^2_m(1 df) = 0.01		χ^2_f(1 df) = 1.99		
Total (for each Time Period)		47	55	48	49	199

TABLE G-34. ANTIBIOTICS DURING STUDY

		In-Basin		Out-of-Basin		
Time	Antibiotics	Males	Females	Males	Females	Total
2/74 to 5/74	Yes	0	3	4	6	13
	No	47	52	44	43	186
		χ^2_m(1 df) = 2.28		χ^2_f(1 df) = 0.77		
5/74 to 10/74	Yes	1	6	5	4	16
	No	46	49	43	45	183
		χ^2_m(1 df) = 1.53		χ^2_f(1 df) = 0.02		
10/74 to 2/75	Yes	2	3	3	5	13
	No	45	52	45	44	186
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.29		
2/75 to 5/75	Yes	5	3	4	4	16
	No	42	52	44	45	183
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.03		
5/75 to 10/75	Yes	7	12	6	7	32
	No	40	43	42	42	167
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.54		
Total (For each Time Period)		47	55	48	49	199

TABLE G-35. ANTIHISTAMINES DURING STUDY

Time	Antihistamines	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	2	4	1	7
	No	47	53	44	48	192
		χ^2_m (1 df) = 2.29		χ^2_f(1 df) = 0.01		
5/74 to 10/74	Yes	0	2	3	1	6
	No	47	53	45	48	193
		χ^2_m(1 df) = 1.33		χ^2_f(1 df) = 0.01		
10/74 to 2/75	Yes	1	4	5	3	13
	No	46	51	43	46	186
		χ^2_m(1 df) = 1.53		χ^2_f(1 df) = 0.03		
2/75 to 5/75	Yes	4	2	5	5	16
	No	43	53	43	44	183
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.89		
5/75 to 10/75	Yes	3	6	6	4	19
	No	44	49	42	45	180
		χ^2_m(1 df) = 0.45		χ^2_f(1 df) = 0.02		
Total (For each Time Period)		47	55	48	49	199

TABLE G-36. AMPHETAMINES OR TRANQUILIZERS DURING STUDY

Time	Amphetamines or Tranquilizers	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	2	0	2	4
	No	47	53	48	47	195
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.15		
5/74 to 10/74	Yes	0	4	1	2	7
	No	47	51	47	47	192
		χ^2_m(1 df) - 0.00		χ^2_f(1 df) = 0.08		
10/74 to 2/75	Yes	0	4	0	2	6
	No	47	51	48	47	193
		χ^2_m(1 df) - 0.00		χ^2_f(1 df) = 0.08		
2/75 to 5/75	Yes	0	3	0	2	5
	No	47	52	48	47	194
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.02		
5/75 to 10/75	Yes	0	4	0	2	6
	No	47	51	48	47	193
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.08		
Total (For Each Period)		47	55	48	49	199

TABLE G-37. OTHER DRUGS DURING STUDY

Time	Other Drugs	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	4	0	2	6
	No	47	51	48	47	193
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.08		
5/74 to 10/74	Yes	0	4	0	3	7
	No	47	51	48	46	192
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.03		
10/74 to 2/75	Yes	0	5	0	4	9
	No	47	50	48	45	190
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.03		
2/75 to 5/75	Yes	0	4	2	4	10
	No	47	51	46	45	189
		χ^2_m(1 df) = 0.48		χ^2_f(1 df) = 0.04		
5/75 to 10/75	Yes	0	5	1	7	13
	No	47	50	47	42	186
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.27		
Total (For each Time Period)		47	55	48	49	199

TABLE G-38. TETANUS SHOTS DURING STUDY

Time	Tetanus Shots	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	1	2	2	0	5
	No	46	53	46	49	194
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.40		
5/74 to 10/74	Yes	0	2	6	2	10
	No	47	53	42	47	189
		χ^2_m(1 df) = 4.34*		χ^2_f(1 df) = 0.15		
10/74 to 2/75	Yes	1	0	0	0	1
	No	46	55	48	49	198
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
2/75 to 5/75	Yes	0	4	1	0	5
	No	47	51	47	49	194
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 2.00		
5/75 to 10/75	Yes	6	0	2	1	9
		41	55	46	48	190
		χ^2_m(1 df) = 1.30		χ^2_f(1 df) = 0.00		
Total (For each Time Period)		47	55	48	49	199

TABLE G-39. ALLERGY SHOTS DURING STUDY

Time	Allergy Shots	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	1	1	0	0	2
	No	46	54	48	49	197
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.00		
5/74 to 10/74	Yes	1	2	0	0	3
	No	46	53	48	49	196
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 0.40		
10/74 to 2/75	Yes	1	3	0	0	4
	No	46	52	48	49	195
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 1.15		
2/75 to 5/75	Yes	1	3	0	0	4
	No	46	52	48	49	195
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 1.15		
5/75 to 10/75	Yes	1	4	0	0	5
	No	46	51	48	49	194
		χ^2_m(1 df) = 0.00		χ^2_f(1 df) = 2.00		
Total (For each Time Period)		47	55	48	49	199

TABLE G-40. OTHER SHOTS DURING STUDY

Time	Other Shots	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	0	0	2	2	4
	No	47	55	46	47	195
		$\chi^2_m(1\ df) = 0.49$		$\chi^2_f(1\ df) = 0.64$		
5/74 to 10/74	Yes	1	2	5	2	10
	No	46	53	43	47	189
		$\chi^2_m(1\ df) = 1.53$		$\chi^2_f(1\ df) = 0.15$		
10/74 to 2/75	Yes	0	1	0	1	2
	No	47	54	48	48	197
		$\chi^2_m(1\ df) = 0.00$		$\chi^2_f(1\ df) = 0.40$		
2/75 to 5/75	Yes	1	2	3	0	6
	No	46	53	45	49	193
		$\chi^2_m(1\ df) = 0.24$		$\chi^2_f(1\ df) = 0.40$		
5/75 to 10/75	Yes	1	3	0	5	5
	No	46	55	48	44	194
		$\chi^2_m(1\ df) = 0.00$		$\chi^2_f(1\ df) = 0.29$		
Total (For each Time Period)		47	55	48	49	199

TABLE G-41. CHEMICAL EXPOSURE DURING STUDY

Time	Chemical Exposure	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	1	2	2	1	6
	No	23	31	30	33	117
	Unknown	23	22	16	15	76
		χ^2_m(1 df) = 0.07		χ^2_f(1 df) = 0.01		
5/74 to 10/74	Yes	1	1	2	1	5
	No	23	32	30	33	118
	Unknown	23	22	16	15	76
		χ^2_m(1 df) = 0.07		χ^2_f(1 df) = 0.48		
10/74 to 2/75	Yes	1	2	3	2	8
	No	23	31	29	32	115
	Unknown	23	22	16	15	76
		χ^2_m(1 df) = 0.05		χ^2_f(1 df) = 0.24		
2/75 to 5/75	Yes	2	3	3	2	10
	No	22	30	29	32	113
	Unknown	23	22	16	15	76
		χ^2_m(1 df) = 0.11		χ^2_f(1 df) = 0.00		
5/75 to 10/75	Yes	3	4	4	4	15
	No	21	29	28	30	108
	Unknown	23	22	16	15	76
		χ^2_m(1 df) = 0.17		χ^2_f(1 df) = 0.11		
Total (For each Time Period)		47	55	48	49	199

TABLE G-42. CIGARETTE SMOKING DURING STUDY

Time	Cigarettes/Day	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	0	38	44	41	37	160
	1-14	4	4	5	4	17
	≥ 15	3	3	0	6	12
	Unknown	2	4	2	2	10
		χ^2_m(2 df) = 3.21		χ^2_f(2 df) = 1.44		
5/74 to 10/74	0	39	43	41	36	159
	1-14	3	4	5	5	17
	≥ 15	3	4	0	6	13
	Unknown	2	4	2	2	10
		χ^2_m(2 df) = 3.54		χ^2_f(2 df) = 0.97		
10/74 to 2/75	0	38	44	38	37	157
	1-14	5	5	6	6	22
	≥ 15	2	4	2	4	12
	Unknown	2	2	2	2	8
		χ^2_m(2 df) = 0.08		χ^2_f(2 df) = 0.34		
2/75 to 5/75	0	38	44	36	34	152
	1-14	6	4	8	6	24
	≥ 15	1	5	2	7	15
	Unknown	2	2	2	2	8
		χ^2_m(2 df) = 0.66		χ^2_f(2 df) = 1.66		
5/75 to 10/75	0	38	47	35	33	153
	1-14	6	4	10	7	27
	≥ 15	1	2	1	7	11
	Unknown	2	2	2	2	8
		χ^2_m(2 df) = 1.11		χ^2_f(2 df) = 5.71		
Total (For each Time Period)		47	55	48	49	199

TABLE G-43. MARIJUANA SMOKING DURING STUDY

Time	Marijuana	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
2/74 to 5/74	Yes	10	5	7	6	28
	No	34	44	37	43	158
	Unknown	3	6	4	0	13
		χ^2_m(1 df) = 0.29		χ^2_f(1 df) = 0.00		
5/74 to 10/74	Yes	9	6	6	8	29
	No	35	44	38	41	158
	Unknown	3	5	4	0	12
		χ^2_m(1 df) = 0.32		χ^2_f(1 df) = 0.11		
10/74 to 2/75	Yes	11	7	7	6	31
	No	34	45	37	43	159
	Unknown	2	3	4	0	9
		χ^2_m(1 df) = 0.55		χ^2_f(1 df) = 0.01		
2/75 to 5/75	Yes	10	8	10	8	36
	No	35	44	34	40	153
	Unknown	2	3	4	1	10
		χ^2_m(1 df) = 0.04		χ^2_f(1 df) = 0.01		
5/75 to 10/75	Yes	10	5	12	5	32
	No	35	47	32	43	157
	Unknown	2	3	4	1	10
		χ^2_m(1 df) = 0.09		χ^2_f(1 df) = 0.04		
Total (For each Time Period)		47	55	48	49	199

TABLE G-44. OCCUPATIONAL EXPOSURE - AG CHEMICALS OR PESTICIDES

	In-Basin		Out-of-Basin		
Exposure	Males	Females	Males	Females	Total
Yes	3	0	2	2	7
No	44	55	46	47	192
Total	47	55	48	49	199

χ^2_m(1 df) = 0.00 χ^2_f(1 df) = 0.64

TABLE G-45. OCCUPATIONAL EXPOSURE - AUTOMOBILE GASES AND FUMES

	In-Basin		Out-of-Basin		
Exposure	Males	Females	Males	Females	Total
Yes	5	0	2	1	8
No	42	55	46	48	191
Total	47	55	48	49	199

χ^2_m(1 df) = 0.66 χ^2_f(1 df) = 0.00

TABLE G-46. OCCUPATIONAL EXPOSURE - LABORATORY CHEMICALS

	In-Basin		Out-of-Basin		
Exposure	Males	Females	Males	Females	Total
Yes	1	4	5	6	16
No	46	51	43	43	183
Total	47	55	48	49	199

χ^2_m(1 df) = 1.53 χ^2_f(1 df) = 0.28

TABLE G-47. OCCUPATIONAL EXPOSURE - RADIOACTIVE CHEMICALS

	In-Basin		Out-of-Basin		
Exposure	Males	Females	Males	Females	Total
Yes	2	0	0	0	2
No	45	55	48	49	197
Total	47	55	48	49	199

χ^2_m(1 df) = 0.53 χ^2_f(1 df) = 0.00

TABLE G-48. OCCUPATIONAL EXPOSURE - MISCELLANEOUS CHEMICALS, DUSTS, FUMES

	In-Basin		Out-of-Basin		
Exposure	Males	Females	Males	Females	Total
Yes	8	3	8	3	22
No	39	52	40	46	177
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 0.05$ $\chi^2_f(1\ df) = 0.08$

TABLE G-49. NUMBER OF SUBJECTS SPENDING ≥ 8 WEEKS IN BASIN SUMMER 1974

	In-Basin		Out-of-Basin		
Time in Basin	Males	Females	Males	Females	Total
≥ 8 weeks	25	37	0	0	62
< 8 weeks/ unknown	22	18	48	49	137
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 31.96$*** $\chi^2_f(1\ df) = 48.27$***

TABLE G-50. NUMBER OF SUBJECTS SPENDING ≥ 8 WEEKS OUT OF BASIN SUMMER 1974

	In-Basin		Out-of-Basin		
Time out of Basin	Males	Females	Males	Females	Total
≥ 8 weeks	2	0	39	45	86
< 8 weeks/ unknown	45	55	9	4	113
Total	49	55	48	49	199

$\chi^2_m(1\ df) = 54.29$*** $\chi^2_f(1\ df) = 85.33$***

TABLE G-51. NUMBER OF SUBJECTS SPENDING ≥ 8 WEEKS IN BASIN SUMMER 1975

	In-Basin		Out-of-Basin		
Time in-Basin	Males	Females	Males	Females	Total
≥ 8 weeks	28	42	7	3	80
< 8 weeks/ unknown	19	13	41	46	119
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 18.77$*** $\chi^2_f(1\ df) = 49.26$***

TABLE G-52. NUMBER OF SUBJECTS SPENDING ≥ 8 WEEKS OUT OF BASIN SUMMER 1975

	In-Basin		Out-of-Basin		
Time Out of Basin	Males	Females	Males	Females	Total
≥ 8 weeks	2	3	31	40	76
< 8 weeks/ unknown	45	52	17	9	123
Total	49	55	48	49	199

$\chi^2_m(1\ df) = 35.51$*** $\chi^2_f(1\ df) = 58.91$***

TABLE G-53. RESIDENCES IN LAST 5 YEARS

	In-Basin		Out-of-Basin		
No. of Years	Males	Females	Males	Females	Total
≥ 2 1/2 Years Rural	0	1	9	7	17
> 2 1/2 Years Urban	38	49	35	39	161
Unknown/Incom-plete	9	5	4	3	21
Total	47	55	48	49	199

$\chi^2_m(1\ df) = 6.76$** $\chi^2_f(1\ df) = 3.89$*

TABLE G-54. YEARS LIVED IN SMSA IN LAST 10 YEARS

	In-Basin		Out-of-Basin		
Years	Males	Females	Males	Females	Total
0	0	0	16	12	28
1-3	0	1	5	2	8
4-6	0	0	2	2	4
7-9	1	6	2	6	15
10	36	43	17	26	122
Unknown	10	5	6	1	22
Total	47	55	48	49	199

$\chi^2_m(2\ df) = 29.01$*** $\chi^2_f(2\ df) = 16.68$***

TABLE G-55. ETHNIC BACKGROUND

Background	In-Basin Males	In-Basin Females	Out-of-Basin Males	Out-of-Basin Females	Total
White	32	35	35	35	137
Oriental	6	8	5	6	25
Black	2	9	4	3	18
Latin American	5	3	3	3	14
Other	1	0	1	0	2
Unknown	1	0	0	2	3
Total	47	55	48	49	199

$\chi^2_m(3\ df) = 1.35$ $\chi^2_f(3\ df) = 2.67$

APPENDIX H

Abnormal Cells Versus Background Variables
Which Were Not Comparable Among Groups

APPENDIX H

TABLE H-1. ABNORMAL CELLS BY AGE - MALES

Sampling Period	Abnormal Cells	In-Basin Age ≤ 19	In-Basin Age > 19	In-Basin Total	Out-of-basin Age ≤ 19	Out-of-basin Age > 19	Out-of-basin Total
October 1974	No	12	16	28	35	6	41
	Yes	11	8	19	7	0	7
		χ^2(1 df) = 0.51			χ^2(1 df) = 0.22		
February 1975	No	12	12	24	22	4	26
	Yes	11	12	23	20	2	22
		χ^2(1 df) = 0.02			χ^2(1 df) = 0.05		
May 1975	No	9	4	13	19	1	20
	Yes	14	20	34	23	5	28
		χ^2(1 df) = 1.95			χ^2(1 df) = 0.78		
October 1975	No	14	8	22	30	3	33
	Yes	9	16	25	12	3	15
		χ^2(1 df) = 2.56			χ^2(1 df) = 0.35		
Total (For each period)		23	24	47	42	6	48

TABLE H-2. ABNORMAL CELLS BY ROUTINE ANTIHISTAMINES

Out-of-Basin Males

Abnormal Cells	Routine Antihistamines	No Antihistamines	Total
No	5	36	41
Yes	1	6	7
Total	6	42	48

χ^2(1 df) = 0.22

TABLE H-3. ABNORMAL CELLS BY CURRENT ANTIHISTAMINES

Out-of-Basin Males

Abnormal Cells	Current Antihistamines	No Antihistamines	Total
No	7	29	36
Yes	1	6	7
Total	8	35	43

$\chi^2(1\ df) = 0.04$

TABLE H-4. ABNORMAL CELLS BY TETANUS SHOTS, MAY TO OCTOBER, 1974

Out-of-Basin Males

Abnormal Cells	Tetanus Shots	No Tetanus Shots	Total
No	6	35	41
Yes	0	7	7
Total			48

$\chi^2(1\ df) = 0.22$

TABLE H-5. ABNORMAL CELLS BY HAY FEVER, OCTOBER, 1974, TO FEBRUARY, 1975

In-Basin Females

Abnormal Cells	Hay Fever	No Hay Fever	Total
No	6	20	26
Yes	3	24	27
Total	9	44	53

$\chi^2(1\ df) = 0.63$

TABLE H-6. ABNORMAL CELLS BY ANTIBIOTIC ALLERGIES

In-Basin Females

Abnormal Cells	Allergy	No Allergy	Total
No	7	29	36
Yes	4	11	15
Total	11	40	51

$\chi^2(1\ df) = 0.04$

TABLE H-7. ABNORMAL CELLS BY X-RAYS TO THE LOWER EXTREMITIES - FEMALES

	In-Basin			Out-of-Basin		
Abnormal Cells	X-rays	No X-rays	Total	X-rays	No X-rays	Total
No	8	32	40	14	23	37
Yes	2	13	15	5	7	12
Total	10	45	55	19	30	49
	χ^2(1 df) = 0.03			χ^2(1 df) = 0.01		

TABLE H-8. ABNORMAL CELLS BY X-RAYS TO THE TRUNK - FEMALES

	In-Basin			Out-of-Basin		
Abnormal Cells	X-Rays	No X-rays	Total	X-rays	No X-rays	Total
No	8	32	40	7	30	37
Yes	1	14	15	1	11	12
Total	9	46	55	8	41	49
	χ^2(1 df) = 0.61			χ^2(1 df) = 0.17		

APPENDIX I

Analysis of Variance of Cell Aberrations - Total Group

Symbol Definitions:

*,**,*** = Statistically significant F-Ratio $p<.05$, $p<.01$, $p<.001$, respectively

(+) +,++,+++ = Statistically significantly greater values for this group than for its corresponding sex group $p<.10$, $p<.05$, $p<.01$, $p<.001$, respectively

APPENDIX I

TABLE I-1

NO. OF ABNORMAL CELLS (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	72.086	24.029	2.9420 *
SUBJECTS IN GROUPS	195	1592.6	8.1673	
TIMES	3	676.10	225.37	27.542 ***
TIMES X GROUPS	9	41.371	4.5968	.56176
TIMES X SUBJECTS IN GROUPS	585	4786.9	8.1828	
TOTAL	795	7169.1		

MEANS | STANDARD DEVIATIONS

TIMES:

GROUPS:		N	Means OCT 74 1	Means FEB 75 2	Means MAY 75 3	Means OCT 75 4	Means TOTAL	SD OCT 74 1	SD FEB 75 2	SD MAY 75 3	SD OCT 75 4	SD TOTAL
IN MALE	1	47	4.647(+)	5.252	7.070	5.572	5.635 +	2.339	2.810	2.998	2.742	2.855
IN FEMALE	2	55	4.181	5.901	6.972	5.633	5.672(+)	2.277	3.186	2.932	2.798	2.971
OUT MALE	3	48	3.524	5.016	6.729	4.634	4.976	1.715	2.467	4.469	2.999	3.268
OUT FEMALE	4	49	4.125	5.243	6.091	5.145	5.151	2.531	2.947	3.012	2.679	2.864
TOTAL		199	4.119	5.372	6.720	5.258	5.367	2.256	2.876	3.394	2.814	3.003

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): May 75 > Feb 75, Oct 75 > Oct 74

TABLE I-2

NO. OF BREAKS (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	79.008	26.336	2.0758
SUBJECTS IN GROUPS	195	2474.0	12.687	
TIMES	3	824.95	274.98	24.112***
TIMES X GROUPS	9	94.648	10.516	.92214
TIMES X SUBJECTS IN GROUPS	585	6671.6	11.404	
TOTAL	795	10144.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	1	47	4.777(+)	5.333	7.194	6.316(+)	5.905 (+)
IN FEMALE	2	55	4.246	6.298	7.141	6.135	5.955
OUT MALE	3	48	3.524	5.016	7.429	4.962	5.233
OUT FEMALE	4	49	4.086	5.321	6.319	5.817	5.386
TOTAL		199	4.159	5.520	7.020	5.817	5.629

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	2.784	2.912	3.654	3.611	3.368
IN FEMALE	2.422	3.995	3.565	3.427	3.540
OUT MALE	1.715	2.467	6.032	3.782	4.083
OUT FEMALE	2.572	3.152	3.328	3.395	3.214
TOTAL	2.428	3.229	4.250	3.562	3.572

Sex Difference (p<.05): None

Significant Time Comparisons (p<.05): May 75 > Feb 75, Oct 75 > Oct 74

TABLE I-3

NO. OF GAPS (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	105.07	35.023	2.8421 *
SUBJECTS IN GROUPS	195	2403.0	12.323	
TIMES	3	4622.6	1540.9	136.85 ***
TIMES X GROUPS	9	97.695	10.855	.96404
TIMES X SUBJECTS IN GROUPS	585	6587.1	11.260	
TOTAL	795	13815.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	1	47	6.453++	9.165	11.355	6.012	8.246 +
IN FEMALE	2	55	6.147(+)	9.057	12.115	6.254	8.393
OUT MALE	3	48	4.582	8.348	10.932	5.940	7.450
OUT FEMALE	4	49	5.035	9.570	11.396	5.584	7.896
TOTAL		199	5.568	9.038	11.473	5.956	8.009

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	3.521	3.727	3.177	3.520	4.087
IN FEMALE	3.403	4.496	2.569	3.270	4.255
OUT MALE	2.729	3.157	3.530	2.835	3.901
OUT FEMALE	3.540	3.638	3.417	3.230	4.364
TOTAL	3.381	3.808	3.182	3.220	4.169

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$); May 75 > Feb 75 > Oct 74, Oct 75

TABLE I-4

NO. OF ISOGAPS (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	9.1953	3.0651	.87569
SUBJECTS IN GROUPS	195	682.54	3.5002	
TIMES	3	152.41	50.805	12.437***
TIMES X GROUPS	9	27.863	3.0959	.75789
TIMES X SUBJECTS IN GROUPS	585	2389.7	4.0849	
TOTAL	795	3261.7		

MEANS

TIMES:

			OCT 74	FEB 75	MAY 75	OCT 75	
GROUPS:		N	1	2	3	4	TOTAL
IN MALE	1	47	3.799	3.936	3.940	3.027	3.676
IN FEMALE	2	55	4.397(+)	3.853	4.307	3.076	3.906
OUT MALE	3	48	3.653	3.870	4.033	3.024	3.645
OUT FEMALE	4	49	3.679	3.801	4.716	3.103	3.825
TOTAL		199	3.897	3.864	4.255	3.059	3.769

STANDARD DEVIATIONS

	OCT 74	FEB 75	MAY 75	OCT 75	
GROUPS:	1	2	3	4	TOTAL
IN MALE	2.478	2.030	2.327	.825	2.041
IN FEMALE	2.759	1.953	2.563	.927	2.218
OUT MALE	1.885	1.921	2.153	.817	1.799
OUT FEMALE	1.967	1.971	2.474	.980	1.997
TOTAL	2.320	1.954	2.392	.886	2.026

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): Oct 74, Feb 75, May 75 > Oct 75

TABLE I-5

NO. OF HYPODIPLOID (PER 25 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	80.437	26.812	.64453
SUBJECTS IN GROUPS	195	8112.0	41.600	
TIMES	3	15665.	5221.6	130.97 ***
TIMES X GROUPS	9	299.00	33.222	.83328
TIMES X SUBJECTS IN GROUPS	585	23324.	39.869	
TOTAL	795	47480.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	1	47	9.819	17.809	20.945	16.309	16.220
IN FEMALE	2	55	9.072	17.260	22.158	18.408	16.725
OUT MALE	3	48	8.223	16.777	21.716	16.736	15.063
OUT FEMALE	4	49	9.405	17.848	20.149	18.103	16.376
TOTAL		199	9.126	17.418	21.270	17.434	16.312

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	6.502	6.623	6.565	5.835	7.531
IN FEMALE	4.628	7.591	7.022	6.287	8.019
OUT MALE	5.816	6.068	5.490	6.310	7.634
OUT FEMALE	7.360	6.833	5.756	6.156	7.707
TOTAL	6.095	6.794	6.265	6.174	7.728

Sex Differences ($p < .05$): None

Significant Time Comparisons ($p < .05$): May 75 > Feb 75, Oct 75 > Oct 74

TABLE I-6

NO. OF HYPERDIPLOID (PER 25 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	13.891	4.6302	.32635
SUBJECTS IN GROUPS	195	2755.6	14.188	
TIMES	3	1301.6	433.86	28.203 ***
TIMES X GROUPS	9	167.98	18.664	1.2133
TIMES X SUBJECTS IN GROUPS	585	8999.2	15.383	
TOTAL	795	132[illegible]9.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	1	47	6.383	7.287	10.360	8.432	8.115
IN FEMALE	2	55	6.236	8.162	9.432	8.117	7.937
OUT MALE	3	48	5.765	7.432	10.056	7.824	7.769
OUT FEMALE	4	49	6.035	9.223	9.091	8.016	8.091
TOTAL		199	6.107	8.041	9.718	8.096	7.991

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	2.237	2.945	5.032	4.192	4.017
IN FEMALE	1.899	3.802	5.301	4.178	4.122
OUT MALE	.762	3.257	5.874	4.011	4.190
OUT FEMALE	1.538	4.011	5.305	3.500	4.016
TOTAL	1.706	3.598	5.367	3.960	4.082

Sex Differences: None

Significant Time Comparisons: May 75 > Feb 75, Oct 75 > Oct 74

TABLE I-7

NO. OF STABLE CHANGES (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	.91895	.30632	.69662
SUBJECTS IN GROUPS	195	85.745	.43972	
TIMES	3	7.6914	2.5638	5.3762 **
TIMES X GROUPS	9	3.0996	.34440	.72220
TIMES X SUBJECTS IN GROUPS	585	278.97	.47688	
TOTAL	795	376.43		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	1	47	2.941	2.941	3.027	3.200	3.027
IN FEMALE	2	55	2.055	2.967	2.929	3.002	2.938
OUT MALE	3	48	2.855	2.855	3.024	3.068	2.951
OUT FEMALE	4	49	2.855	2.855	2.855	3.268	2.958
TOTAL		199	2.876	2.907	2.957	3.130	2.967

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	TOTAL
IN MALE	.590	.590	.825	1.141	.819
IN FEMALE	.000	.829	.545	.764	.624
OUT MALE	.000	.000	.817	1.052	.668
OUT FEMALE	.000	.000	.000	1.237	.639
TOTAL	.287	.521	.635	1.052	.688

Sex Differences ($p<.05$): None

Significant Time Trends ($p<.05$): Oct 75 > Oct 74, Feb 75, May 75

TABLE I-8

NO. OF ENDOREDUPLICATION (PER 100 CELLS, TRANSFORMED)

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	1.1523	.38411	.81585
SUBJECTS IN GROUPS	195	91.809	.47081	
TIMES	3	6.3047	2.1016	4.1622**
TIMES X GROUPS	9	12.614	1.4016	2.7759**
TIMES X SUBJECTS IN GROUPS	585	295.37	.50491	
TOTAL	795	407.25		

MEANS

TIMES:

		OCT 74	FEB 75	MAY 75	OCT 75	
GROUPS:	N	1	2	3	4	TOTAL
IN MALE 1	47	2.941	2.855	3.330++	2.855	2.996
IN FEMALE 2	55	2.929	2.929	3.370+++	2.855	3.021
OUT MALE 3	48	2.855	2.940	2.940	2.940	2.918
OUT FEMALE 4	49	2.938	2.938	2.855	3.146+	2.969
TOTAL	199	2.916	2.916	3.130	2.947	2.977

STANDARD DEVIATIONS

	OCT 74	FEB 75	MAY 75	OCT 75	
GROUPS:	1	2	3	4	TOTAL
IN MALE	.590	.000	1.419	.000	.787
IN FEMALE	.545	.545	1.360	.000	.803
OUT MALE	.000	.584	.584	.584	.503
OUT FEMALE	.578	.578	.000	1.176	.719
TOTAL	.494	.494	1.052	.656	.716

Sex Differences ($p < .05$); None

Significant Time Trends ($p < .05$); May 75 > Oct 74, Feb 75, Oct 75

APPENDIX J

Analysis of Variance of Cell Aberrations - Rescan Group

Symbol Definitions:

(*),*,**,*** = Statistically significant F-Ratio p<.10, p<.05, p<.01, p<.001, respectively

(+),+,++,+++ = Statistically significantly greater values for this group than for its corresponding sex group p<.10, p<.05, p<.01, p<.001, respectively

APPENDIX J

TABLE J-1

NO.OF ABNORMAL CELLS (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	121.42	40.472	5.9440**
SUBJECTS IN GROUPS	64	435.77	6.8089	
TIMES	4	108.14	27.035	3.5646**
TIMES X GROUPS	12	83.516	6.9596	.91762
TIMES X SUBJECTS IN GROUPS	256	1941.6	7.5844	
TOTAL	339	2690.5		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	4.767	5.895	7.140	4.757	5.737	5.659
IN FEMALE	2	17	5.756	7.689 +	7.129	6.715	6.544	6.767+
OUT MALE	3	18	5.121	6.644	6.182	3.529	4.756	5.127
OUT FEMALE	4	17	6.330	5.654	6.030	5.244	5.820	5.816
TOTAL		68	5.499	6.323	6.606	5.043	5.700	5.834

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	2.635	2.950	2.867	2.283	2.901	2.811
IN FEMALE	3.214	3.113	2.435	3.028	2.385	2.862
OUT MALE	2.705	3.048	3.075	1.551	2.614	2.772
OUT FEMALE	2.481	3.073	2.760	2.413	2.465	2.612
TOTAL	2.776	3.087	2.783	2.591	2.618	2.817

Sex Differences ($p<.05$): Females > Males

Significant Time Comparison ($p<.05$): May 75 > Oct 74, Oct 75

Feb 75 > Oct 75

TABLE J-2

NO. OF BREAKS (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	136.67	45.555	3.8047*
SUBJECTS IN GROUPS	64	766.31	11.974	
TIMES	4	107.61	26.902	2.0144(*)
TIMES X GROUPS	12	162.01	13.501	1.0109
TIMES X SUBJECTS IN GROUPS	256	3410.8	13.355	
TOTAL	339	4591.4		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	5.395	6.421	8.076	5.630 (+)	6.701	6.446 (+)
IN FEMALE	2	17	6.074	8.171	7.487	7.647	6.963	7.268
OUT MALE	3	18	5.332	6.457	6.934	3.305	5.695	5.545
OUT FEMALE	4	17	7.289	6.112	6.849	6.460	6.902	6.722
TOTAL		68	6.022	6.791	7.320	5.728	6.550	6.482

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	4.739	3.597	3.626	3.653	3.967	3.956
IN FEMALE	3.554	3.768	3.234	3.993	3.124	3.537
OUT MALE	2.986	3.989	3.843	1.308	4.026	3.546
OUT FEMALE	3.336	3.771	3.326	3.706	3.816	3.534
TOTAL	3.687	3.793	3.474	3.627	3.704	3.680

Sex Differences ($p<.05$): Females > Males

Significant Time Comparisons ($p<.05$); May 75 > Oct 74, Oct 75

TABLE J-5

NO. OF GAPS (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	316.52	105.51	9.6096***
SUBJECTS IN GROUPS	64	702.67	10.979	
TIMES	4	642.12	160.53	14.375***
TIMES X GROUPS	12	125.45	10.454	.93613
TIMES X SUBJECTS IN GROUPS	256	2858.9	11.167	
TOTAL	339	4645.6		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	6.371	7.472	9.244	5.375	7.769	7.246
IN FEMALE	2	17	9.458+	10.938(+)	11.301	7.787++	7.939	9.485+++
OUT MALE	3	18	6.550	8.153	8.150	5.440	6.902	7.039
OUT FEMALE	4	17	6.935	8.922	10.326	4.293	8.161	7.727
TOTAL		68	7.331	8.881	9.739	5.725	7.680	7.871

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	3.094	3.118	2.895	3.459	4.515	3.624
IN FEMALE	3.438	4.656	2.679	3.747	4.611	4.078
OUT MALE	2.677	2.304	2.633	2.835	3.414	2.922
OUT FEMALE	3.448	2.329	3.459	2.367	3.731	3.675
TOTAL	3.346	3.418	3.106	3.326	4.020	3.702

Sex Differences (p<.05); Females > Males

Significant Time Comparisons (p.<05); May 75, Feb 75 > Oct 74, May 76 > Oct 75

TABLE J-4

NO. OF ISOGAPS (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	5.0664	1.6888	1.2037
SUBJECTS IN GROUPS	64	89.795	1.4030	
TIMES	4	13.631	3.4078	2.3075 (*)
TIMES X GROUPS	12	14.045	1.1705	.79254
TIMES X SUBJECTS IN GROUPS	256	378.07	1.4768	
TOTAL	339	500.61		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	3.108	3.361	3.361	3.108	3.614	3.310
IN FEMALE	2	17	3.807+	3.093	3.807	3.093	3.331	3.426 (+)
OUT MALE	3	18	3.305	2.855	3.305	2.855	3.754	3.215
OUT FEMALE	4	17	2.855	2.855	3.569	3.093	3.093	3.093
TOTAL		68	3.272	3.034	3.510	3.034	3.450	3.260

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1.011	1.382	1.382	1.011	1.630	1.286
IN FEMALE	1.769	.981	1.769	.981	1.343	1.417
OUT MALE	1.308	.003	1.308	.003	1.730	1.158
OUT FEMALE	.003	.003	1.589	.981	.981	.957
TOTAL	1.238	.837	1.500	.837	1.443	1.215

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): May 75 > Feb 75, Oct 75

TABLE J-5

NO. OF HYPODIPLOID (PER 25 CELLS. TRANSFORMED) FOR RESCAN GROUPS. USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	25.000	8.3333	.30495
SUBJECTS IN GROUPS	64	1748.9	27.327	
TIMES	4	1634.2	408.56	10.734***
TIMES X GROUPS	12	956.94	79.745	2.0952*
TIMES X SUBJECTS IN GROUPS	256	9743.7	38.061	
TOTAL	339	14109.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	20.975	23.527	19.748	15.484	16.008	19.149
IN FEMALE	2	17	14.767	24.118	24.018	18.501	17.425	19.766
OUT MALE	3	18	19.739	20.301	20.112	18.076	17.315	19.109
OUT FEMALE	4	17	15.467	21.713	22.112	19.164	17.288	19.149
TOTAL		68	17.719	22.367	21.503	17.845	17.028	19.292

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	5.313	4.903	6.986	6.496	6.869	6.746
IN FEMALE	9.500	4.133	4.357	6.514	7.274	7.497
OUT MALE	4.073	6.651	6.696	5.224	5.840	5.775
OUT FEMALE	4.575	4.402	6.259	4.991	6.014	5.773
TOTAL	6.648	5.260	6.256	5.861	6.389	6.451

Sex Differences (p<.05): None

Significant Time Comparisons (p<.05): Feb 75, May 75 > Oct 74, Oct 75, May 76

TABLE J-6

NO. OF HYPERDIPLOID (PER 25 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	3.7227	1.2409	.17386
SUBJECTS IN GROUPS	64	456.78	7.1371	
TIMES	4	104.20	26.049	2.7956 *
TIMES X GROUPS	12	95.906	7.9922	.85772
TIMES X SUBJECTS IN GROUPS	256	2385.4	9.3179	
TOTAL	339	3046.0		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	7.140	6.400	6.409	7.651	6.315	6.818
IN FEMALE	2	17	7.475	6.602	5.655	8.630	6.897	7.052
OUT MALE	3	18	8.016	5.655	7.207	6.969	7.601	7.090
OUT FEMALE	4	17	7.681	7.164	6.602	7.785	5.966	7.040
TOTAL		68	7.593	6.465	6.499	7.749	6.714	7.004

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	2.742	2.332	2.332	3.157	1.803	2.502
IN FEMALE	3.676	2.674	.000	4.834	2.308	3.222
OUT MALE	3.150	.000	3.781	3.146	4.160	3.236
OUT FEMALE	2.898	3.587	2.674	3.735	1.280	2.975
TOTAL	3.088	2.511	2.621	3.744	2.680	2.998

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): Oct 74, Oct 75 > Feb 75, May 75

TABLE J-7

NO. OF STABLE CHANGES (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	3.6465	1.2155	.97583
SUBJECTS IN GROUPS	64	79.718	1.2456	
TIMES	4	9.1031	2.2958	1.9262
TIMES X GROUPS	12	7.7510	.64591	.54193
TIMES X SUBJECTS IN GROUPS	256	305.12	1.1919	
TOTAL	339	405.42		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	3.240	3.108	2.855	3.361	3.361	3.185
IN FEMALE	2	17	3.093	3.093	2.855	3.093	3.331	3.093
OUT MALE	3	18	2.855	2.855	3.080	2.855	3.529	3.035
OUT FEMALE	4	17	2.855	3.217	3.331	3.569	3.569	3.308
TOTAL		68	3.005	3.065	3.034	3.212	3.450	3.153

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1.538	1.011	.003	1.382	1.382	1.185
IN FEMALE	.981	.981	.003	.981	1.343	.957
OUT MALE	.003	.003	.953	.003	1.551	.838
OUT FEMALE	.003	1.492	1.343	1.589	1.589	1.342
TOTAL	.887	1.004	.837	1.156	1.443	1.094

Sex Differences (p<.05): None

Significant Time Comparisons (p<.05): May 76 > Oct 74, May 75

TABLE J-8

NO. OF ENDOREDUPLICATION (PER 100 CELLS, TRANSFORMED) FOR RESCAN GROUPS, USING RESCAN VALUES

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	.14600	.48665E-01	.17579
SUBJECTS IN GROUPS	64	17.718	.27684	
TIMES	4	.62842	.15710	.53850
TIMES X GROUPS	12	3.2324	.26937	.92330
TIMES X SUBJECTS IN GROUPS	256	74.687	.29175	
TOTAL	339	96.412		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	3.108	2.855	2.855	2.855	2.855	2.906
IN FEMALE	2	17	2.855	2.855	3.093	2.855	3.093	2.950
OUT MALE	3	18	2.855	2.855	2.855	3.080	2.855	2.900
OUT FEMALE	4	17	3.093	2.855	2.855	3.093	2.855	2.950
TOTAL		68	2.974	2.855	2.915	2.974	2.915	2.927

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1.011	.003	.003	.003	.003	.452
IN FEMALE	.003	.003	.981	.003	.981	.617
OUT MALE	.003	.003	.003	.953	.003	.426
OUT FEMALE	.981	.003	.003	.981	.003	.617
TOTAL	.688	.003	.491	.688	.491	.533

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): None

APPENDIX K

Analysis of Variance of Satellite Association - Rescan Group

Symbol Definitions:

(*),*,** = Statistically significant F-ratio $p<.10$, $p<.05$, $p<.01$, respectively

(+),+ = Statistically significantly greater values for this group than for its corresponding sex group $p<.10$, $p<.05$, respectively

APPENDIX K

TABLE K-1

NO. OF D'S (PER 150 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	208.[illegible]	69.542	1.2869
SUBJECTS IN GROUPS	64	3458.3	54.036	
TIMES	4	344.37	86.094	3.3926*
TIMES X GROUPS	12	265.25	22.104	.87103
TIMES X SUBJECTS IN GROUPS	256	6496.5	25.377	
TOTAL	339	10773.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	34.722	31.648	33.097	33.411	28.593	32.294
IN FEMALE	2	17	33.799	31.999	34.073	34.595	32.070	33.307
OUT MALE	3	18	31.855	30.036	31.439	32.885	30.432	31.329
OUT FEMALE	4	17	32.763	33.014	31.781	34.567	33.204	33.066
TOTAL		68	33.242	31.651	32.573	33.857	31.102	32.485

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 75 5	TOTAL
IN MALE	4.325	5.488	5.153	4.361	4.927	5.193
IN FEMALE	6.102	6.545	5.652	5.013	8.207	6.334
OUT MALE	4.778	5.458	5.066	6.397	7.075	5.777
OUT FEMALE	4.502	5.825	5.244	4.287	5.150	4.993
TOTAL	4.989	5.817	5.272	5.060	6.598	5.637

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): Oct 75 > Feb 75, May 76

Oct 74 > May 76

TABLE K-2

NO. OF G'S (PER 100 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	568.37	189.46	1.9468
SUBJECTS IN GROUPS	64	6228.4	97.319	
TIMES	4	202.69	50.672	1.6906
TIMES X GROUPS	12	332.56	27.714	.92460
TIMES X SUBJECTS IN GROUPS	256	7673.2	29.973	
TOTAL	339	15005.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 '4	MAY 76 5	TOTAL
IN MALE	1	16	35.948	34.055	33.525	34.829	34.678	34.607
IN FEMALE	2	17	34.829	35.684	37.585	36.265	35.069	35.886
OUT MALE	3	18	34.344	30.653	35.624	33.066	31.786	33.094
OUT FEMALE	4	17	36.468	34.979	36.000	38.530	35.939	36.303
TOTAL		68	35.374	33.793	35.714	35.647	34.325	34.970

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	5.854	6.457	7.175	5.110	8.729	6.656
IN FEMALE	7.753	7.056	4.560	6.097	5.639	6.247
OUT MALE	7.664	6.243	6.321	5.369	6.108	6.488
OUT FEMALE	7.618	7.756	5.661	5.350	7.637	6.825
TOTAL	7.178	7.029	6.030	5.747	7.114	6.653

Sex Differences ($p<.05$): Females > Males

Significant Time Comparisons ($p.<05$): None

TABLE K-3

GROUPS OF 2 (PER 125 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	144.72	48.240	3.2397 *
SUBJECTS IN GROUPS	64	952.97	14.890	
TIMES	4	174.25	43.562	4.5707 **
TIMES X GROUPS	12	80.375	6.6979	.70277
TIMES X SUBJECTS IN GROUPS	256	2439.9	9.5308	
TOTAL	339	3792.2		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	27.822	25.367	26.891	26.309	24.403	25.998
IN FEMALE	2	17	27.257	26.102	26.617	25.568	25.750	26.259
OUT MALE	3	18	25.963	24.409	25.437	25.231	24.125	25.033
OUT FEMALE	4	17	27.815	24.961	26.973	27.190	27.095	26.807
TOTAL		68	27.187	25.196	26.270	26.059	25.339	26.010

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	2.336	2.830	3.817	2.926	4.225	3.410
IN FEMALE	3.746	3.590	2.590	2.536	4.039	3.335
OUT MALE	2.854	3.334	3.647	2.592	2.646	3.050
OUT FEMALE	3.067	4.524	2.781	2.478	3.420	3.392
TOTAL	3.080	3.602	3.230	2.685	3.727	3.345

Sex Differences ($p<.05$); Females > Males

Significant Time Comparisons ($p<.05$); Oct 74 > Feb 75, Oct 75, May 76

TABLE K-4

GROUPS OF 3 (PER 75 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	168.34	56.115	2.9583 *
SUBJECTS IN GROUPS	64	1214.0	18.969	
TIMES	4	206.91	51.727	2.7536 *
TIMES X GROUPS	12	286.37	23.865	1.2704
TIMES X SUBJECTS IN GROUPS	256	4809.1	18.785	
TOTAL	339	6684.7		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	17.343	17.581 +	15.635	17.312	15.134	16.601
IN FEMALE	2	17	16.965	16.653	18.386	19.582	15.258	17.369
OUT MALE	3	18	16.743	14.363	15.973	17.153	15.852	16.017
OUT FEMALE	4	17	16.357	19.257(+)	16.553	19.380	17.586	17.827
TOTAL		68	16.843	16.916	16.642	18.354	15.968	16.945

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	3.608	4.152	3.453	4.212	4.838	4.106
IN FEMALE	4.170	4.464	4.052	3.917	4.578	4.403
OUT MALE	4.678	5.927	3.920	4.235	4.506	4.697
OUT FEMALE	4.267	4.095	4.179	4.872	3.820	4.355
TOTAL	4.134	4.980	3.975	4.376	4.455	4.441

Sex Differences ($p < .05$); Females > Males

Significant Time Comparisons ($p < .05$); Oct 75 > May 75, May 76

TABLE K-5

GROUPS OF 4 OR MORE (PER 50 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	76.609	25.536	.65885
SUBJECTS IN GROUPS	64	2480.6	38.759	
TIMES	4	150.82	37.705	1.4727
TIMES X GROUPS	12	218.65	18.221	.71165
TIMES X SUBJECTS IN GROUPS	256	6554.5	25.603	
TOTAL	339	9481.1		

MEANS / STANDARD DEVIATIONS

TIMES:

GROUPS:		N	Means OCT 74 1	Means FEB 75 2	Means MAY 75 3	Means OCT 75 4	Means MAY 76 5	Means TOTAL	SD OCT 74 1	SD FEB 75 2	SD MAY 75 3	SD OCT 75 4	SD MAY 76 5	SD TOTAL
IN MALE	1	16	12.190	11.601	13.406	12.474	10.846	12.104	5.894	4.391	5.847	5.296	6.359	5.519
IN FEMALE	2	17	11.296	11.738	14.663+	13.577	14.216	13.098	5.078	5.980	3.461	5.912	5.572	5.330
OUT MALE	3	18	11.906	10.641	13.612	12.825	11.474	12.091	4.460	5.310	5.486	5.296	6.182	5.355
OUT FEMALE	4	17	11.529	12.113	10.729	13.301	11.672	11.869	4.562	5.264	4.700	4.612	5.752	4.952
TOTAL		68	11.726	11.509	13.106	13.049	12.061	12.290	4.906	5.188	5.056	5.195	5.977	5.288

Sex Differences (p<.05): None

Significant Time Comparisons (p<.05): None

TABLE K-6

NO. OF D-D'S (PER 375 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	26.500	8.8333	.40218
SUBJECTS IN GROUPS	64	1405.7	21.964	
TIMES	4	100.33	25.082	4.4499 **
TIMES X GROUPS	12	56.422	4.7018	.83358
TIMES X SUBJECTS IN GROUPS	256	1443.3	5.6378	
TOTAL	339	3032.2		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	12.390	10.885	11.230	11.368	9.516	11.078
IN FEMALE	2	17	11.451	10.677	11.491	12.564	10.572	11.351
OUT MALE	3	18	10.856	10.263	10.301	11.453	10.075	10.590
OUT FEMALE	4	17	10.796	11.402	10.413	11.604	10.391	10.921
TOTAL		68	11.351	10.798	10.845	11.749	10.146	10.978

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	2.534	2.554	2.210	2.655	2.433	2.592
IN FEMALE	2.728	3.349	3.339	3.108	4.200	3.376
OUT MALE	2.066	2.974	3.087	3.594	3.444	3.173
OUT FEMALE	1.744	3.039	2.610	2.865	3.195	2.720
TOTAL	2.536	2.960	2.841	3.059	3.338	2.991

Sex Differences (p<.05): None

Significant Time Comparisons (p<.05): Oct 75 > Feb 75, May 75, May 76

Oct 74 > May 76

TABLE K-7

NO. OF D-G'S (PER 600 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	35.477	11.826	2.1976 (*)
SUBJECTS IN GROUPS	64	344.39	5.3811	
TIMES	4	31.234	7.8086	2.1744 (*)
TIMES X GROUPS	12	28.008	2.3340	.64991
TIMES X SUBJECTS IN GROUPS	255	919.35	3.5912	
TOTAL	339	1358.5		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	11.587	11.624	12.040	12.229	11.023	11.700
IN FEMALE	2	17	12.062	11.611	12.403	12.411	11.846	12.082
OUT MALE	3	18	11.922	10.942	11.994	11.770	11.093	11.544
OUT FEMALE	4	17	12.129	11.944	11.926	13.105	12.721	12.365
TOTAL		68	11.930	11.520	12.110	12.372	11.672	11.921

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	2.652	2.142	2.418	1.350	2.114	2.165
IN FEMALE	1.963	2.162	1.524	1.571	2.514	1.962
OUT MALE	2.242	1.676	1.421	1.860	1.911	1.890
OUT FEMALE	2.554	2.019	1.747	1.537	1.511	1.925
TOTAL	2.317	2.057	1.776	1.637	2.112	2.002

Sex Differences (p<.05); Females > Males

Significant Time Comparisons (p<.05); Oct 75 > Feb 75, May 76

TABLE K-8

NO. OF G-G'S (PER 150 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	135.69	45.229	1.0370
SUBJECTS IN GROUPS	64	2791.5	43.616	
TIMES	4	41.125	10.281	.96138
TIMES X GROUPS	12	205.86	17.155	1.6041 (*)
TIMES X SUBJECTS IN GROUPS	256	2737.7	10.694	
TOTAL	339	5911.9		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	13.201	12.520(+)	11.803	12.698	13.646	12.774
IN FEMALE	2	17	11.776	13.671	14.441	13.912	12.986	13.357
OUT MALE	3	18	12.257	10.168	13.608	11.928	11.577	11.908
OUT FEMALE	4	17	14.333(+)	13.210	13.474	13.886	12.481	13.477
TOTAL		68	12.878	12.358	13.358	13.094	12.642	12.866

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	3.333	4.433	4.113	3.638	4.838	4.050
IN FEMALE	5.385	3.985	3.232	3.917	2.666	3.950
OUT MALE	4.502	4.945	4.418	3.994	4.157	4.456
OUT FEMALE	4.556	4.261	3.476	4.131	4.142	4.078
TOTAL	4.526	4.544	3.875	3.935	4.000	4.176

Sex Differences ($p<.05$): None

Significant Time Comparisons ($p<.05$): None

TABLE K-9

NO. OF CELLS WITH NO ASSOCIATIONS (PER 25 POSSIBLE, TRANSFORMED) FOR RESCAN GROUPS

ANALYSIS OF VARIANCE TABLE FOR REPEATED MEASURES DESIGN

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	F-RATIO
GROUPS	3	108.94	36.312	.48913
SUBJECTS IN GROUPS	64	4751.3	74.239	
TIMES	4	1127.5	281.87	4.1731 **
TIMES X GROUPS	12	424.03	35.336	.52314
TIMES X SUBJECTS IN GROUPS	256	17292.	67.546	
TOTAL	339	23704.		

MEANS

TIMES:

GROUPS:		N	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	1	16	20.434	25.437	26.392	22.947	27.657	24.573
IN FEMALE	2	17	23.094	26.094	23.505	23.899	27.099	24.738
OUT MALE	3	18	25.059	28.902	25.860	22.198	27.481	25.900
OUT FEMALE	4	17	22.732	28.000	25.112	22.414	24.538	24.559
TOTAL		68	22.898	27.159	25.209	22.853	26.691	24.962

STANDARD DEVIATIONS

GROUPS:	OCT 74 1	FEB 75 2	MAY 75 3	OCT 75 4	MAY 76 5	TOTAL
IN MALE	7.478	9.541	7.959	6.497	10.036	8.592
IN FEMALE	10.254	8.183	7.384	7.072	9.753	8.562
OUT MALE	7.129	8.154	8.575	9.310	9.379	8.663
OUT FEMALE	9.261	7.885	6.927	6.534	6.916	7.657
TOTAL	8.586	8.371	7.649	7.350	8.979	8.362

Sex Differences ($p<.05$); None

Significant Time Comparisons ($p<.05$); Feb 75, May 76 > Oct 74, Oct 75

TECHNICAL REPORT DATA SHEET
BY EPA

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/1-78-054	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Chromosomal Aberrations in Peripheral Lymphocytes of Students Exposed to Air Pollutants		5. REPORT DATE August 1978 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Charles D. Scott and John A. Burkart		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Utah Biomedical Test Laboratory University of Utah Research Institute 520 Wakara Way Salt Lake City, Utah 84108		10. PROGRAM ELEMENT NO. 1AA601 11. CONTRACT/GRANT NO. 68-02-1730
12. SPONSORING AGENCY NAME AND ADDRESS Health Effects Research Laboratory RTP,NC Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, N.C. 27711		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE EPA-600/11
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This research program was initiated with the overall objective of determining whether or not photochemical air pollutants have the potential to cause chromosome breakage in environmentally exposed individuals; if so, could chromosomal changes be used as a biological indicator of exposure to certain environmental conditions in the Los Angeles, CA basin.

256 incoming Freshmen students at the University of So. California were selected, matched, and grouped by home address into in-basin males and females, and out-of-basin males and females. Blood samples were collected from them at the following sampling time: October 1974, February, May and October 1975, and May 1976. All slides were analyzed in a double blind fashion, with 100 cells per student per sampling time being scored. All 100 cells were analyzed for chromosome and chromatid aberrations; however, only 25 cells of this 100 were counted for aneuploidy. Overall, in-basin males had significantly more abnormal cells, breaks, and gaps than out-of-basin males. Females showed the same trends but only for abnormal cells were the results borderline statistically significant. Differences between the two groups of students were more pronounced at both October evaluations than at the February and May evaluations. Chromosome abnormalities in general showed increases from October 1974 through May 1975 and then decreased by October 1975. These changes followed similar trends in levels of carbon monoxide, nitrogen oxides, and ozone.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
carbon monoxide nitrogen oxides ozone chromosome abnormalities air pollution	students Los Angeles California	06, F

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 177
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE

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